TECHNOLOGY DEPT.

TECHNOLOGY REVIEW

November 1952

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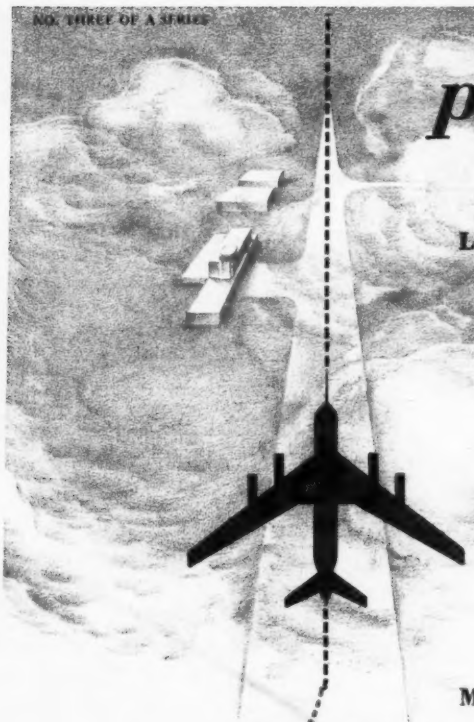


pioneers in precision

Lear, Incorporated

Manufacturers of Precision Engineered Products, Lear has pioneered in the miniaturization of aviation instruments since 1930. Lear designed and produced automatic pilots have been accepted for use in jet fighter planes as well as in commercial aircraft for single engine or multi engine airplanes. The Lear Automatic Pilot and Approach Coupler permits safe landings despite extreme weather or visibility conditions.

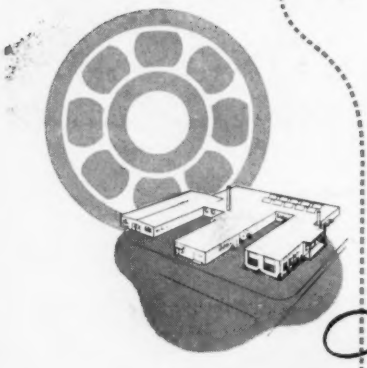
Miniature Precision Bearings

incorporated, are the originators and pioneer manufacturers of radial ball bearings in miniature sizes. For and with Lear, **MPB** designed the first miniature flange bearings and has supplied many thousands of this and additional types.

A pioneer in other designs and dimensions now being internationally standardized, **MPB** has also originated many precision manufacturing techniques. High speed bore grinding was first explored and finally perfected in this plant. For nearly ten years, this recently publicized method has been standard practice at **MPB**. In fact, the original concept of practically every development in this field has been by **MPB**.

Regularly supplied in more than 120 types, sizes, and materials, from 1/10" to 7/16". Special designs are supplied where specifically indicated. They are fully ground, lapped, honed, and/or burnished to ABEC 5 tolerances or better.

MPB ball bearings have been installed in more than a million precision mechanisms. Design engineers are assured of full cooperation. Write, requesting Catalog 52B–shows complete range and selection data – engineering sheet TR 11



Quality improvement, continued thru an extensive expansion program has prompted a demand greater than ever. Enlarged facilities however, and newest exclusive processes will soon enable us to serve you better than ever.

Miniature *precision* Bearings

Incorporated Keene, New Hampshire

"pioneer precisionists to the World's foremost instrument Manufacturers"

save space weight friction

Tech

Catching fish with ground glass

Your ultra-modern fiber glass fishing rod, like the familiar steel and bamboo types, depends on grinding for the "feel", balance and springiness that make it a real "precision fishing instrument."

One type of glass rod contains over 850,000 microscopic glass strands, bound together by heat. It is ground to a predetermined taper—accurate to .001 inch—with a Norton CRYSTOLON grinding wheel in a centerless grinder. Another type is precision-finished with Behr-Manning coated abrasives.

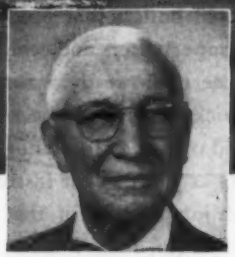
As with fishing rods, grinding is essential to the manufacture or maintenance of every man-made product. And as the world's largest manufacturers of abrasives and abrasive products for every grinding and polishing operation, Norton and Behr-Manning serve all industry by the product-development that helps improve other products.

NORTON makes abrasives, grinding wheels, pulpstones, refractories, grinding and lapping machines, non-slip floors, Norbide grain and molded products. Norton Company, Worcester 6, Mass.

BEHR-MANNING makes abrasive paper and cloth, oilstones, abrasive specialties, Behr-Cat brand pressure-sensitive tapes. Behr-Manning Corporation, Division of Norton Company, Troy, New York.

Plants, Distributors and Dealers the world over

COLIN A. ROSS, packaging development engineer at Behr-Manning for 23 years, has made many valuable contributions to modern "Service Packaging" and labelling of coated abrasives.



CHARLES J. HUDSON is chiefly responsible for the outstanding excellence of Norton's quality control. Now in his 34th year at Norton, he is a recognized authority in his field.

NORTON

BEHR-MANNING

Making better products to make other products better

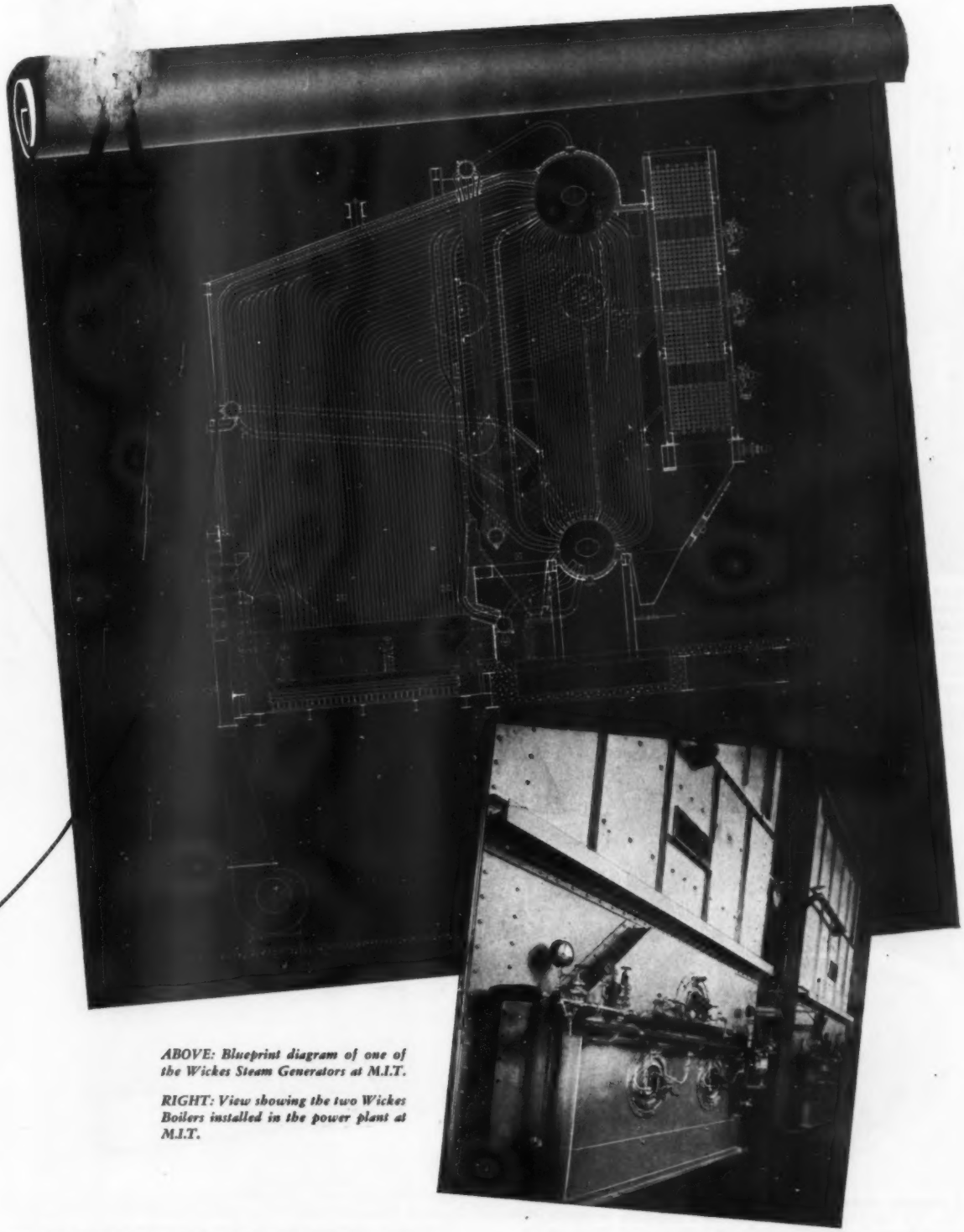
NORTON · BEHR-MANNING

THE TECHNOLOGY REVIEW, November, 1952, Newsstand Edition, Vol. LV, No. 1. Published monthly from November to July inclusive at Emmett Street, Bristol, Conn. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription, $4.00. Entered as second-class matter December 23, 1949, at the Post Office at Bristol, Conn., under the Act of March 3, 1879.

M.I.T.,

AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, where sound engineering principles are taught, two Wickes Steam Generators were selected to supply heat for several new buildings including the Hayden Library and Sloan Metals Research Laboratory. The Wickes Boilers, which were custom-engineered for M.I.T., produce 160,000 lbs., of steam per hour. They occupy the same space formerly occupied by the two old boilers that produced only 40,000 lbs. per hour. They are equipped with superheaters and economizers. The new boilers are oil-fired at present but are engineered for ready conversion to spreader stoker if desired. They are designed for quick steaming to meet emergency power requirements and are fitted with thermowells and openings for taking flue gas samples so the students at M.I.T. can run boiler tests as part of their instruction. The installation of these boilers, an extremely difficult job because of the close erection tolerances, was handled by Flagg, Brackett & Durgin, Inc., Wickes' agents in Boston. ✓ ✓ ✓ Wickes can fill your requirements for steam generators up to 250,000 lbs. per hour and 1000 psi.—all types of multiple drum boilers adaptable to any standard method of firing; oil, gas, underfeed or spreader stoker. Write today for descriptive literature or consult your nearest Wickes representative.

RECOGNIZED QUALITY SINCE 1854



ABOVE: Blueprint diagram of one of the Wickes Steam Generators at M.I.T.

RIGHT: View showing the two Wickes Boilers installed in the power plant at M.I.T.

WICKES

THE WICKES BOILER CO.

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

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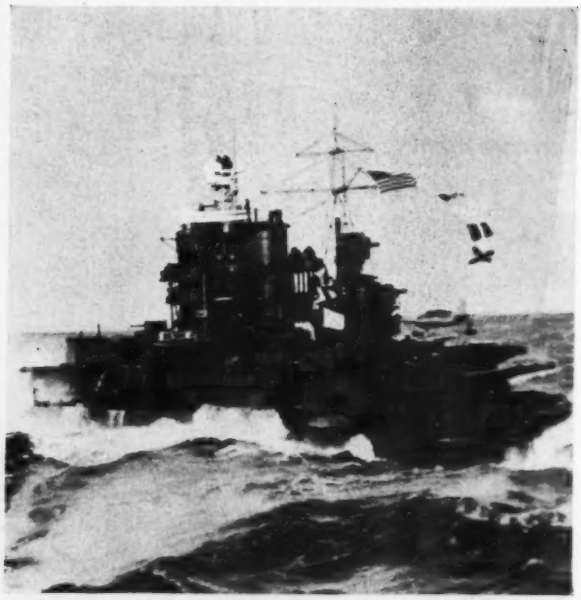
How would YOU control costs here?

POOR PRINTING can be costly to newspapers. It may cause paper waste . . . free ad repeats . . . even circulation losses. Faulty temperature control in the lead alloy metal pots of linotype machines can cause fuzzy, broken type. But not with the control manufactured by Linotype Parts Company, Inc., using accurate Fenwal THERMOSWITCH® thermostats.



HIGH CORROSION SPECIFICATIONS must be met by Armed Forces products. A salt-fog and humidity testing cabinet, made by Industrial Filter & Pump Mfg. Co., Chicago, makes sure corrosion resistance specs are met before costly deliveries are made. Tests involve close control of temperature . . . achieved by a Fenwal Junction-Box THERMOSWITCH thermostat, in each cabinet.

A FENWAL THERMOSWITCH CONTROL* may cut your costs, too. Its external, single-metal shell expands or contracts *instantly* with temperature changes, making or breaking enclosed electrical contacts. Compact, highly resistant to shock and vibration, Fenwal THERMOSWITCH units have solved hundreds of otherwise costly problems.

*Junction Box Type Illustrated.

SEND FOR THIS NEW CATALOG for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. Write Fenwal, Incorporated, 911 Pleasant Street, Ashland, Massachusetts.

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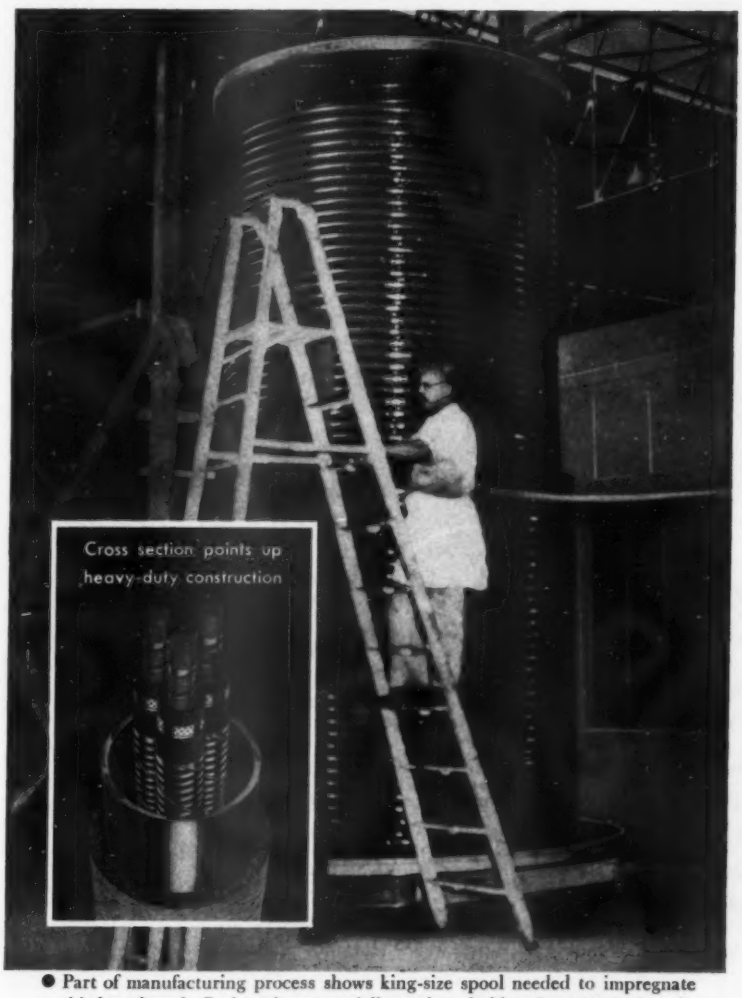
Electric Temperature Control and Detection Devices

SENSITIVE . . . *but only to heat*

LONGEST LENGTH 138,000 VOLT CABLE!

6800-ft. Compression Cables without Splices built by Phelps Dodge for service under N.Y. Harbor



● Part of manufacturing process shows king-size spool needed to impregnate this long length. Each reel was specially made to hold entire 6800-ft. length.

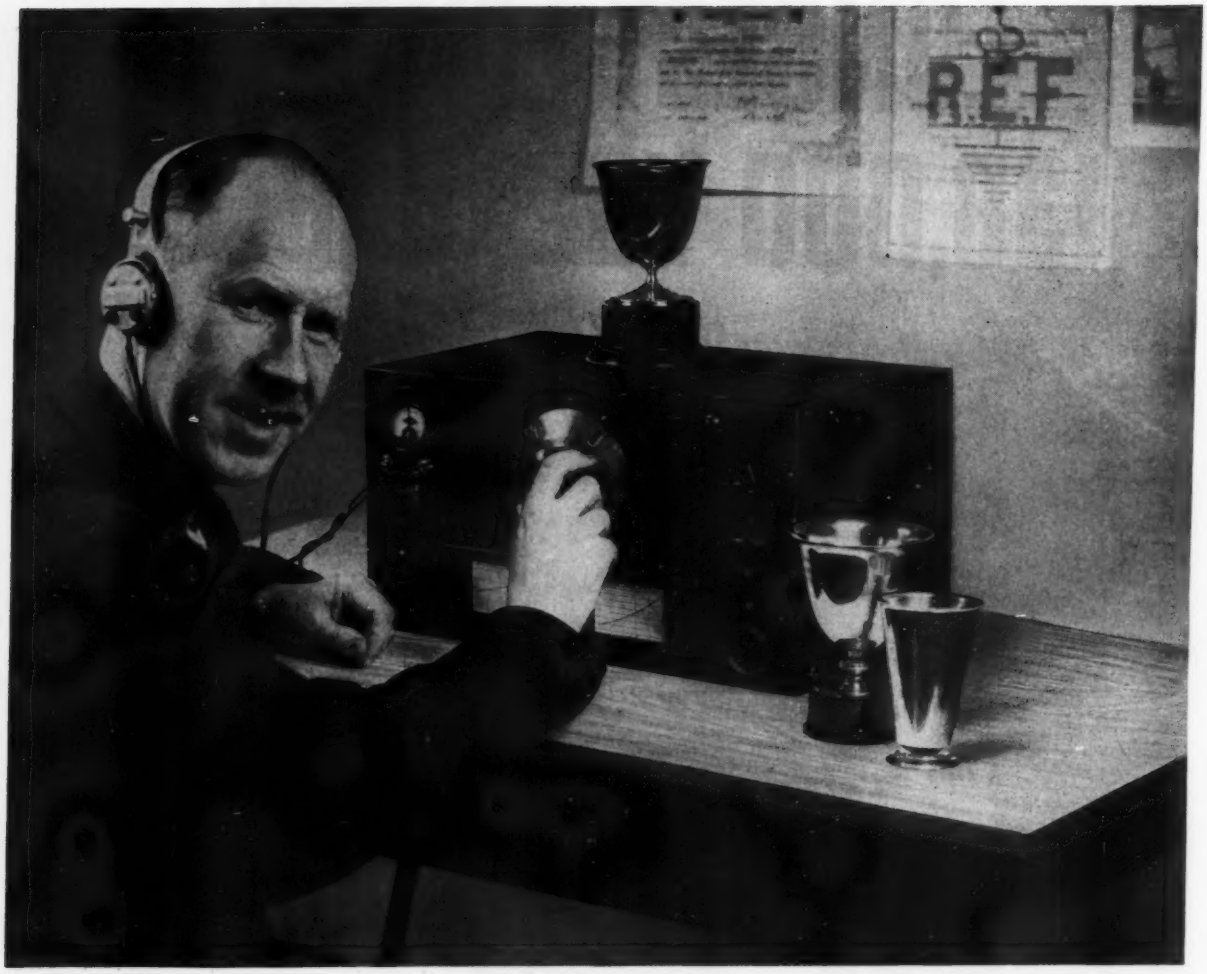
Consolidated Edison's unusual underwater installation uses record-length conductors for two pipe-type feeders, each consisting of three 1,500,000-cm compression cables, between Brooklyn and Staten Island

As a result of years of pioneering research and experience in handling the "tough" jobs, Phelps Dodge was in a position to manufacture the special underwater cables needed to integrate Con Edison's new Staten Island affiliate with its main system.

For both economy and ease of its installation, Con Edison wanted each cable made in a continuous 6800-ft. length—longest ever specified. At present the cables will operate at 27 kv, but are designed for ultimate operation at 138 kv.

Waterproof polyethylene sheath was used to give the insulation extra protection from moisture and damage during shipment and installation. This was important because it was expected that the cables might be exposed for a considerable time during the long pull into the pipes buried in the Narrows at the entrance to New York Harbor. The sheath also provides for additional safety if, at any time after installation, the pipes were to be damaged and water find its way into the pipes.

PHELPS DODGE COPPER PRODUCTS CORPORATION



17 Years of Prize-Winning Performance

To paraphrase a well-known quotation,
"Old HRO's never die!" Nor, may we hasten to add, do they "fade away."

In 1934, the year he got his amateur license, Gerard de Buren, HB9AW (Geneva), FP8AW (St. Pierre and Miquelon), purchased an HRO. He's still using it with prize-winning results. In 17 years, his HRO has helped him win one amateur award after another. Just this year, on St. Pierre and Miquelon Islands, he worked 1285 stations in 53 countries in 35 days!

Enduring performance like this is built into every National product.

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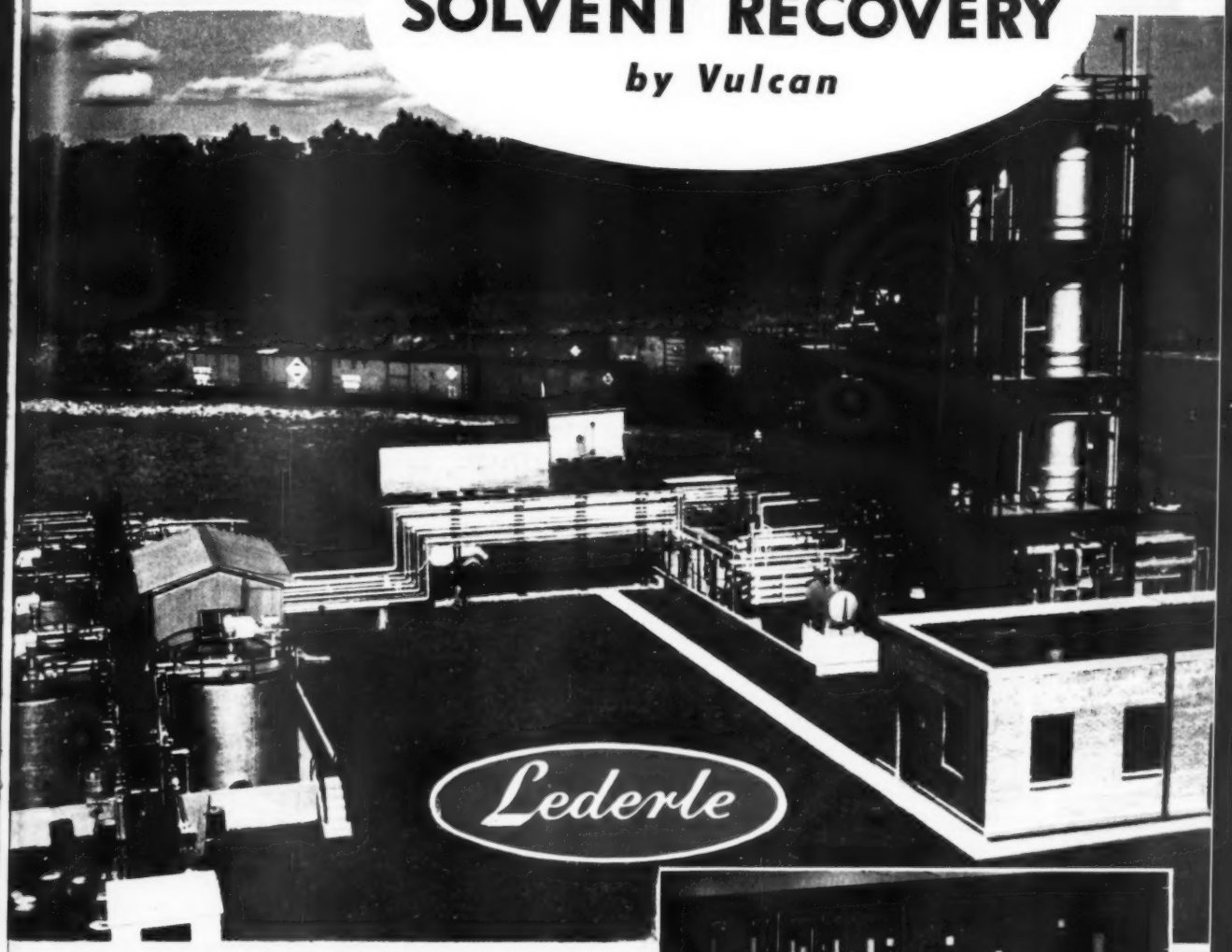
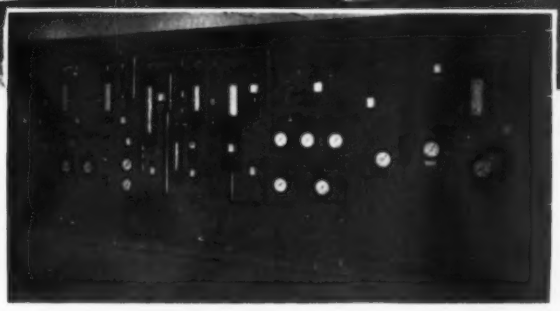
and efficient

SOLVENT RECOVERY

by Vulcan





In the big new aureomycin plant of Lederle Laboratories Division of the American Cyanamid Company at Pearl River, N. Y., solvent recovery is vital. Solvents must be recovered for reuse in better than 99% purity if the process is to be economically feasible.

Vulcan in cooperation with Lederle designed a complete unit for recovery of the many solvents used. Vulcan also supplied all equipment and materials and supervised construction.

Five separate feed streams are handled in four distillation trains consisting of seven towers. Operating control of the unit is entirely automatic and is regulated from a graphic panel in the control house. Complete flexibility accommodates wide variations in flow rates and compositions of the various feed streams. Process alterations are thus possible without major changes in the solvent recovery unit.

The result? Less cost, less time lost in turning out the product.

CINCINNATI

The VULCAN COPPER & SUPPLY CO.,

General Offices and Plant, **CINCINNATI 2, OHIO**

NEW YORK BOSTON PHILADELPHIA SAN FRANCISCO

VICKERS VULCAN PROCESS ENGINEERING CO., LTD., MONTREAL, CANADA

DIVISIONS OF THE VULCAN COPPER & SUPPLY CO.:

VULCAN ENGINEERING DIVISION • VULCAN MANUFACTURING DIVISION • VULCAN CONSTRUCTION DIVISION • VULCAN INDUSTRIAL SUPPLY DIVISION

You will always win by using TIREX portable cords and cables. When you "write in" TIREX on your requisitions for portable cords and cables you vote for top-quality, long-life, and trouble-free service.

Those who buy and use TIREX tell us they like the tough TIREX neoprene armor. It provides the kind of wearability and snagproof service their operations demand. They are more than satisfied too with the smooth, dense jacket that is a product of the **cured-in-lead process** used on all TIREX cords and cables.

Since TIREX is oil, acid, alkali and flame resistant, it will help to curtail your maintenance costs and will postpone the day of your portable cord or cable replacement. Whenever you purchase a portable cord or cable be sure to specify and get Simplex-TIREX for economy, quality, and satisfaction. They are always marked for your protection.

TIREX is made in a wide range of sizes and types from a single-conductor #18 cord for 300 V.W.P. all the way up to 3-conductor Type SH-D cable for voltages in excess of 10,000 V.W.P.

SIMPLEX—TIREX NEOPRENE ARMOR

SIMPLEX TIREX

SIMPLEX WIRE & CABLE CO., 79 SIDNEY ST., CAMBRIDGE 39, MASS.

Overall View of the New Service Center

SERVICE CENTER *for a* SERVICE COMPANY

Newest in materials handling design throughout

Headquarters for maintenance, purchasing, stores and stores accounting of the Beaumont electric transmission and distribution division

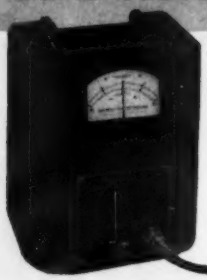
The construction of this new Service Center at Beaumont, Texas, is one of many projects undertaken by Stone & Webster Engineering Corporation for Gulf States Utilities Company.

The new facilities include unloading dock and railroad spur, specially constructed yards for heavy equipment storage, the office building with auditorium and kitchen, the storehouse, a substation, garage, and paint shop.

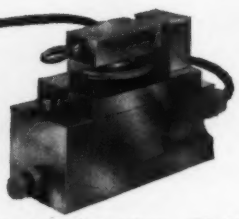
STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY *of* STONE & WEBSTER, INC.

SPECIAL FIXTURES



speed multiple inspection with Brown & Sharpe Electronic Equipment



HERE'S how you can get faster, more accurate gaging of small parts — at low cost. Special gaging fixtures, custom-built by Brown & Sharpe, in combination with Brown & Sharpe Electronic Amplifiers, check all critical dimensions quickly, to tolerances of .00001". Applicable to gaging thickness, length, angle, parallelism, diameter, taper, or combinations of several dimensions. If desired, fixtures may be ordered for use with your present Brown & Sharpe Amplifiers. For details, write Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

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THE TABULAR VIEW

Partnership for Progress.—With expenditures for the current year amounting to some three billion dollars, scientific research has indeed become "big business." Moreover, properly conducted research is undoubtedly one of the mainstays of national defense, and therefore, one may argue, its continuance would be inexpensive at almost any price which does not wreck our national economy. Yet we cannot afford to waste our effort; indeed, we must husband all of our resources for maximum effectiveness, as Technology's President, JAMES R. KILLIAN, JR., '26, points out (page 23).

Dr. Killian suggests that "industry has a stake in making sure that enough first-rate young people move into these fields" of science and engineering to meet the nation's legitimate man-power needs. A total of about 125,000 scientists and engineers now carry the research load in the United States but the importance of their work is far beyond that which this relatively small number would suggest. Encouragement for the training of future scientists and engineers is to be derived from the fact that, through provision of fellowships, grants-in-aid, and similar support, industry has already made it possible for "our privately financed and endowed institutions to survive the debilitating disease of inflation." Yet universities are able to support only 5 per cent of today's current research budget in contrast to 15 per cent of the nation's research expenditures as of two decades ago. President Killian's article, originally delivered as an address before a convention of Heating, Piping, and Air Conditioning Contractors, concludes with a plea "for increasingly close relationships between industry, government, and education."

In extracts from the President's Report to the Corporation (page 34), this issue of The Review also contains another major contribution from the pen of Dr. Killian.

Size No Virtue.—"Bigger and better" is an old American slogan in which, all too frequently, the greater share of emphasis is associated with the first "B." But bigness is not necessarily a virtue and may even be a serious detriment, as FREDERIC W. NORDSIEK, '31, points out (page 27). In fact, in a highly technological society, substantial deviation from the median value (whether on the large, or small, end of the frequency distribution curve) is accompanied by a certain degree of inconvenience which can, and sometimes does, reach devastating proportions. Mr. Nordsiek takes pains to show that the outsize man is a victim of modern technology, and that his clothing, housing, transportation, and even occupation, may all be substantially affected by the economics of mass-production techniques.

For the most part limiting his observations to the effects of supply of clothing, Mr. Nordsiek cites difficulties of providing, from stock, wearing apparel for the huge, or the diminutive, individual. Clothing sup-

(*Concluded on page* 12)

BEYOND THE HORIZON....

Designers are seeking new alloys from the metallurgist in order to develop higher speed transportation.

Higher speed calls for materials having greater strength in lighter sections, often with little or no sacrifice in toughness. Molybdenum contributes vital properties to better alloys which will certainly be developed for the future.

Climax furnishes authoritative engineering data on Molybdenum applications.

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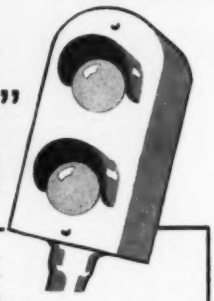
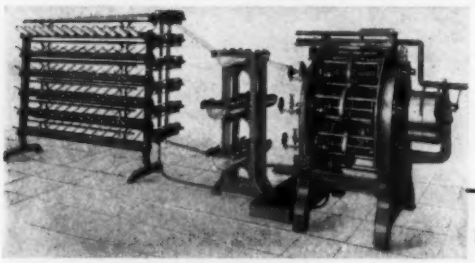
Put An End to "STOP AND GO" PRODUCTION!



Your machine output, like the flow of traffic, can be *speeded up!* Faster movement to lower unit-production costs, is *simplified* with new, improved H-D twisters, ropers, layers, bunchers, stranders! Take for example, the new H-D 10" x 8" Former-Twister double head. It produces 15,000 feet per hour per machine on work being closed with 12 turns per foot. Typical of the high hourly output of *all* H-D machines. Let our engineering department show you how YOU benefit. Get our bulletins — TODAY.

HASKELL-DAWES MACHINE CO., INC.
2231 E. ONTARIO ST., PHILADELPHIA 34, PA.

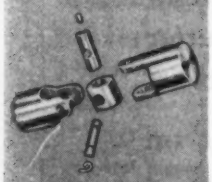


CREEL STOP MOTION TAPE 10" x 5" SIX FLYER

Fewer Parts make easy assembly

Simple construction, fewer parts make assembly and disassembly easy — also mean longer life.

CURTIS UNIVERSAL JOINTS



Simple construction is not the whole story. A combination of modern design, wise choice of alloy steels, with a special heat treatment for each part, give greater strength with less weight. And you can depend on Curtis catalog ratings — they are based on hundreds of actual tests.

ONLY CURTIS OFFERS ALL THESE ADVANTAGES

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Government Tests — complete equipment for government tests in our plant.

the only Universal Joint with the "Telltale" Lock Ring (patented)

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CURTIS UNIVERSAL JOINT CO., INC.
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As near to you as your telephone

A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

THE TABULAR VIEW

(*Concluded from page 10*)

ply for the outsize person becomes so difficult and uneconomical a problem, where large masses of persons are concerned, that the armed forces now ruthlessly exclude from military service warriors who may be oversize, quite in contrast to the practice in earlier periods of individualized combat. From Mr. Nordsiek's study also comes an interesting discussion of the manner in which size designations of men's wearing apparel are determined.

Menace or Myth?—Gruesome contribution to today's thinking is the recognition that warfare of the future might inflict international carnage through bacteriological techniques. The possibility of germ warfare is one thing; the extent to which Leeuwenhoek's "little beasties" could lay a great nation prostrate is quite another. Perhaps no one can say, with accuracy, how devastating bacteriological warfare would be in surprise attacks. But a realistic and rational approach to the problem yields the satisfaction that public enlightenment, surveillance by public health officials, and preparedness on the part of a nation's armed forces should be effective in preventing attacks aimed at spreading disease, and in effectively combating any epidemics which might take hold. Bacteriological warfare is definitely not a myth, as JAMES A. TOBEY, '15, points out (page 31), but neither is it a cause for undue hysteria. Dr. Tobey received the S.B. and Dr.P.H. degrees from M.I.T. in 1916 and 1927, respectively, the LL.B. degree from Washington Law School in 1922, the M.S. degree from the American University in 1923. To his outstanding career of service in the broad field of public service, Dr. Tobey has recently had the distinction of serving on active duty in Korea as Colonel with the Army Medical Service. Dr. Tobey's presentation in this issue of The Review is, in part, a result of his Army contacts, and gives assurance that the problem is receiving serious study.

35 ANNIVERSARY

On July 5th we celebrated our 35th Anniversary. Since the founding of our company, we have specialized in industrial construction, and have executed over 1000 contracts for leading industrial companies. In recent years, 60% to 70% of our business has come from clients for whom we have previously built—evidence of work well done.

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Founded 1917
101 Park Avenue, New York
INDUSTRIAL CONSTRUCTION
Alfred T. Glassett, '20, President

Nature was working for you...a billion years ago

Age-old natural gas—changed beyond recognition by the hand of science—is in nearly everything that's new today

Geologists tell us that centuries ago mountains rose and crumbled . . . oceans formed and disappeared . . . and great masses of plant and animal life were buried under layers of earth, rock, and water. Gradually, chemical reactions changed that buried matter into oil and natural gas.

IT IS IMPORTANT TO ALL OF US—Natural gas came into its own within the lifetime of many of us. Its great importance began when scientists learned to separate and use its parts. Out of this work in the field of petro-chemistry came "Prestone" anti-freeze, the all-winter type that took the worry out of cold weather driving. Then there are today's plastics. Some are so soft and pliable that they make beautiful, long-lasting curtains and drapes for your home. Others are so tough and enduring that they are used to protect the bottoms of ocean liners. Natural gas products are important ingredients in nearly all of them.

FROM ANTI-FREEZE TO FUEL—Wherever you turn, there's something that's been made better by the magic touch of chemistry. It brings you many of today's life-saving wonder drugs . . . man-made fibers for exciting new textiles . . . hundreds of useful chemicals . . . and also "Pyrofax" gas, the modern bottled gas for home, farm, and industry.

UCC AND CHEMISTRY—The people of Union Carbide pioneered in producing synthetic organic chemicals. Today, their plants turn out more than 350 of these versatile chemicals for industry to use in making the things that serve you so well.

STUDENTS and STUDENT ADVISERS: *Learn more about the many fields in which Union Carbide offers career opportunities. Write for the free illustrated booklet "Products and Processes" which describes the various activities of UCC in the fields of* ALLOYS, CARBONS, CHEMICALS, GASES, *and* PLASTICS. *Ask for booklet I-2.*

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DYNEL TEXTILE FIBERS • BAKELITE, KRENE, and VINYLITE Plastics • LINDE Oxygen • SYNTHETIC ORGANIC CHEMICALS

What GENERAL ELECTRIC People Are Saying

G. B. WARREN

Turbine Division

THE ENGINEER IN PUBLIC LIFE: The value of the engineer in public life is measured by his knowledge of industrial engineering and power economics, his understanding of structures in the broad sense, and his honesty of approach, developed because he has learned that nature can't be cheated . . . can't be made to produce something for nothing.

A good engineer gets all the facts he can before deciding on a course of action, examines possible alternative courses and the results that would accrue, and tries to select the optimum. Qualifications for men in public service should be the same.

I believe we need the practical, informed, and so, intellectually honest, approach to public affairs that the engineer has brought to our private industrial affairs. This cannot, in my judgment, be obtained by the part-time attention of engineers on a layman basis in government, but must be obtained by professionally trained public administrators who will need much, but not all, of the technical training of the engineer, supplemented by the broader training required of this field.

University of Wisconsin
4th Annual Engineers' Day

★

E. D. TROUT

X-Ray Department

REDUCING X-RAY DOSAGE: Because of the increased portion of the total population now receiving radiation from so many sources, it may well be that the long term effects of doses too small to produce an acute effect are important. Certain it is that, in view of the increased use of radiation in all its forms to such a large percentage of our people, there is an obligation on the part of all who use radiation to subject the patient to as small a dose as is consistent with an adequate examination. Anything that can be done to reduce the dose will be a step in the right direction.

It is hoped that we will become aware of, and establish, limitations to prevent the nonacute and long term effects of small doses of radiation which presently appear to be nonreversible once the effect has been initiated and which may not be restricted in their influence to a single generation.

52nd Annual Meeting
American Roentgen Ray Society

★

J. C. AYDELOTT

Transportation Department

RAILROAD ELECTRIFICATION: In this country the trend is toward very heavy trains, and speeds are gradually increasing as road beds are improved and better riding cars replace the old ones. High horsepower to handle such trains in the future comes easily with electrification—provided we look ahead in the selection of a suitable system. It will be to no one's benefit to be tied to a system that inherently limits the horsepower that can be made available to a train, or a system that is not equally adaptable to high-horse-power locomotives and conversion of existing diesel-electric locomotives.

The urge to lower the cost of electrification is, of course, what prompts us to look hopefully at every possible system. But there are other proved ways of getting costs down that are far more effective than starting with a blank piece of paper and a new dream every time the question of railroad electrification comes up. I am referring, of course, to the genius of American repetitive manufacture. There is far greater benefit to be realized by standardization—both in manufacture and operation—than can ever be hoped for by hunting for a unique solution for a given set of conditions on a particular railroad.

G-E Review

W. E. JOHNSON

Nucleonics Division

THE SOCIAL IMPACT OF THE ATOMIC INDUSTRY: One concept of possibly great social importance is the fact that atomic energy gives us at last very definite evidence that there is nothing very substantial in the real world of ours. It will probably take decades and perhaps generations for a consciousness of the unsubstantial nature of the universe to sink into the minds of people and to influence their social conduct and their spiritual beliefs. The fact that all of the substantial matter in the bodies of all the people in New York City could be put into a single cubic inch and other similar information will, in due course, have its influence on the minds and the social consciousness of people.

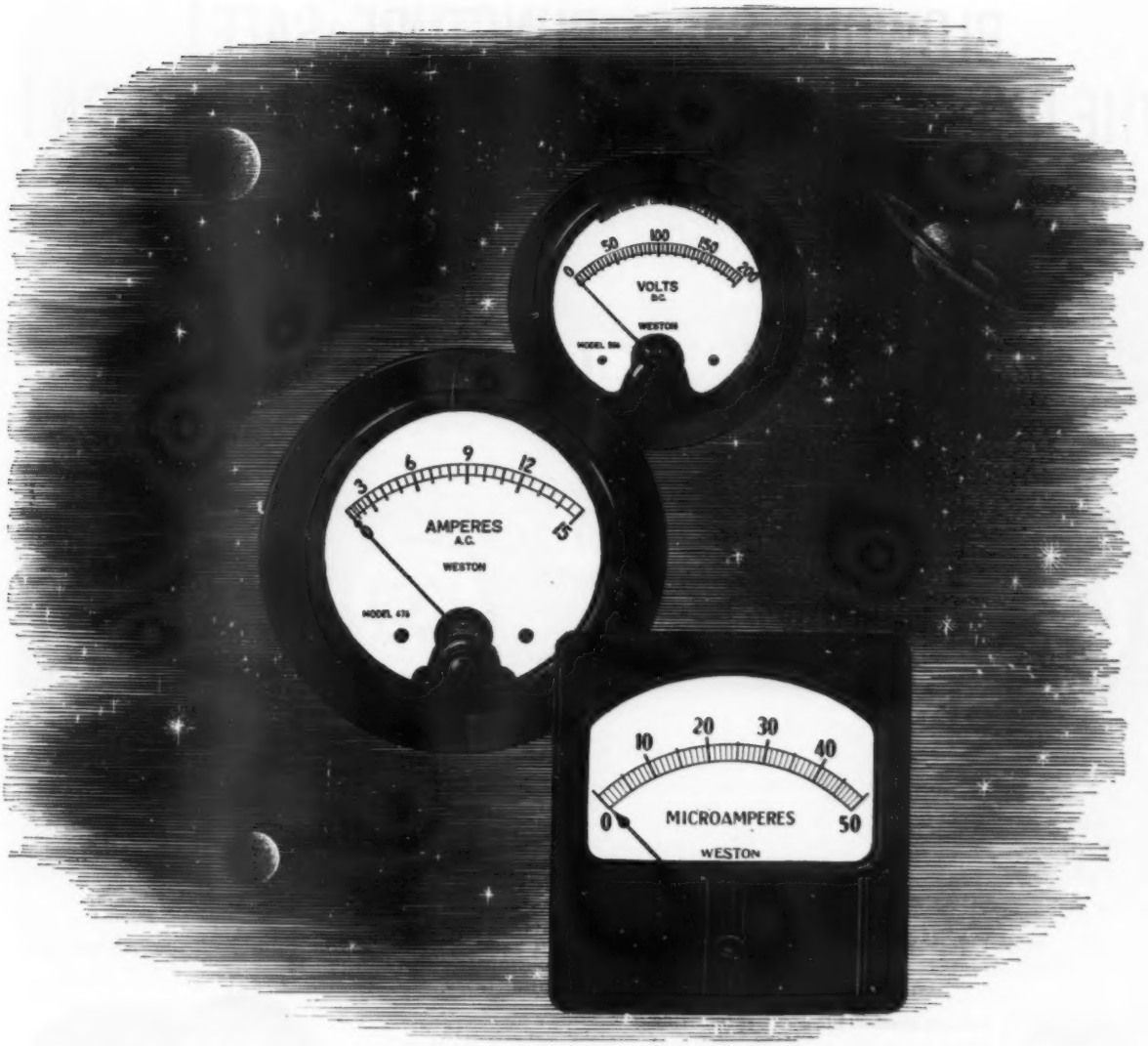
One more effect on our social structure is that brought about by the economic impact of this industry. At the moment, I think we must admit that the economic effects are negative and that from the standpoint of usable products or productive power that might increase the wealth of the nation, we are still, so to speak, in the red. However, the future looks bright even here and it is almost a certainty that practical methods will be found to make use of nuclear energy for such things as propulsion of ships and submarines. If we look at this as a first major step toward an industrial type of application, we can look toward the long-term future of this industry with greater confidence.

Finally, with continued growth, increasing knowledge and sustained confidence in our own future, I think we shall soon find that achievement rather than destruction will be the measure of our progress.

Prof. Engineers Northwest Centennial
Portland, Oregon

You can put your confidence in—

GENERAL ELECTRIC



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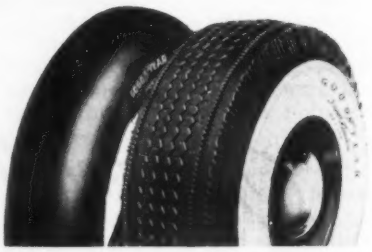

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by GOODYEAR

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Harold M. Lambert

"Yet ah! why should they know their fate,
Since sorrow never comes too late,
And happiness too swiftly flies?
Thought would destroy their paradise."
– Thomas Gray

THE TECHNOLOGY REVIEW

TITLE REGISTERED, U. S. PATENT OFFICE

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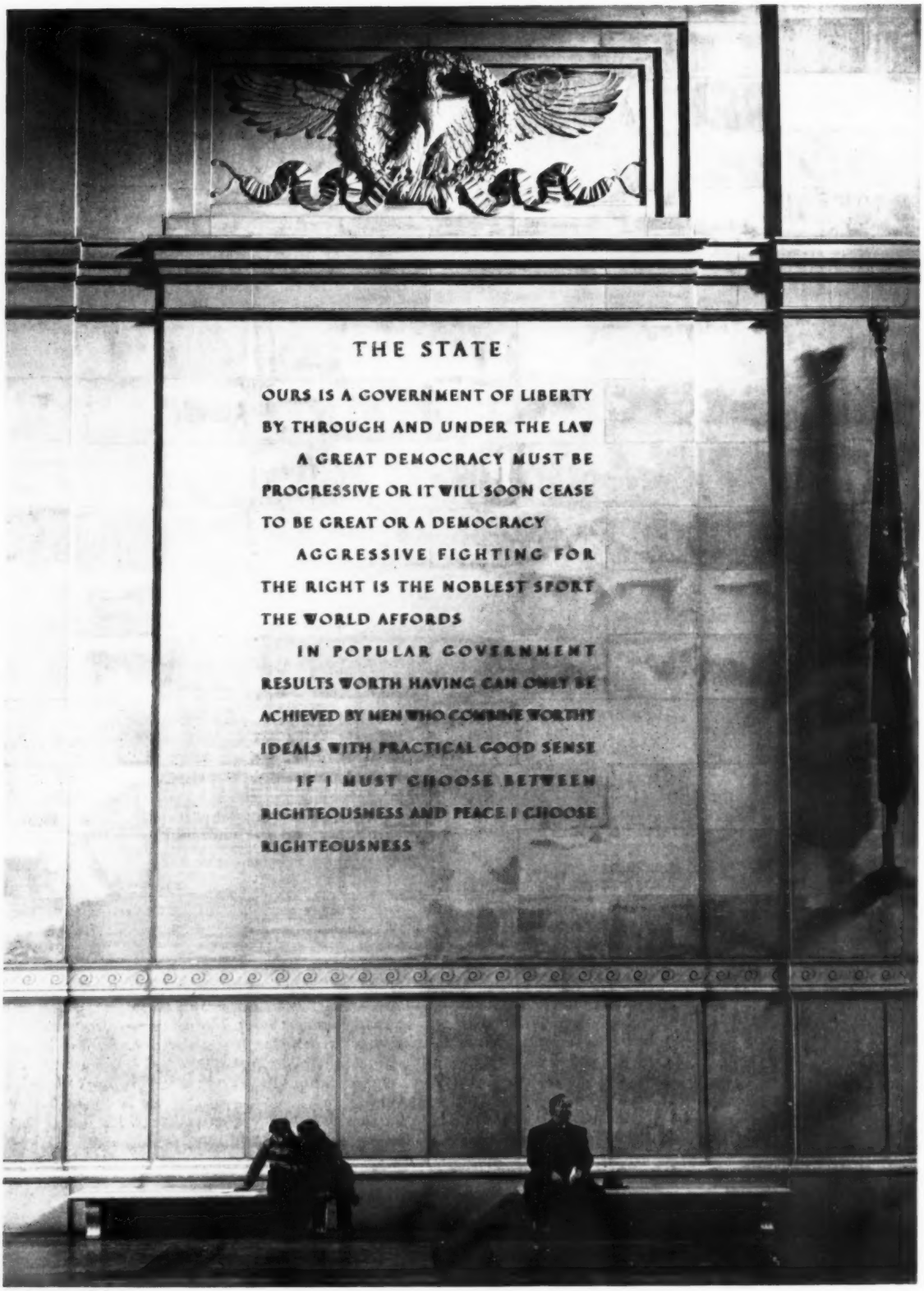
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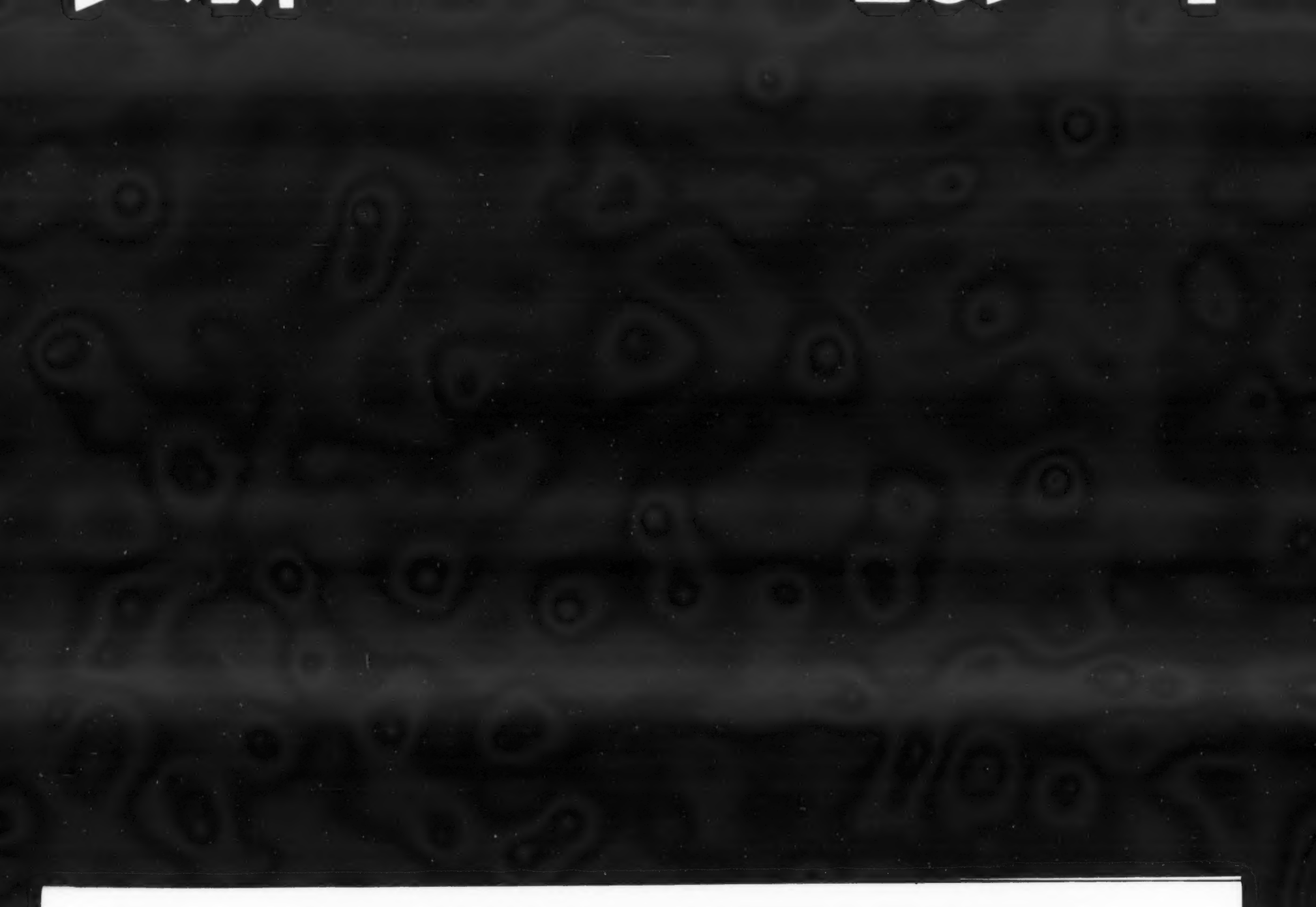
AGGRESSIVE FIGHTING FOR THE RIGHT IS THE NOBLEST SPORT THE WORLD AFFORDS
IN POPULAR GOVERNMENT RESULTS WORTH HAVING CAN ONLY BE ACHIEVED BY MEN WHO COMBINE WORTHY IDEALS WITH PRACTICAL GOOD SENSE
IF I MUST CHOOSE BETWEEN RIGHTEOUSNESS AND PEACE I CHOOSE RIGHTEOUSNESS

H. Armstrong Roberts

Theodore Roosevelt Memorial Hall
Museum of Natural History, New York City



THE
TECHNOLOGY
REVIEW

Vol. 55, No. 1 November, 1952

The Trend of Affairs

Centennial of Engineering

Held in Chicago from September 3 to 13, the Centennial of Engineering commemorated the founding of the first national society of engineers in the United States just 100 years ago. At its inception, this society comprised all branches of engineering devoted to civilian affairs, and, to distinguish its members from engineers engaged in military activities, was called the American Society of Civil Engineers.

The principal purposes of the Centennial of Engineering were: to promote a better understanding by the public of the principles which have made the United States a great nation, particularly in the field of technology; and to foster a better understanding of the engineering profession itself. With the nation confronted by a substantial shortage in well-qualified technical man power during the same period when it depends more and more upon the scientist and engineer for maintaining its economic and social systems, the centennial convocation came at a particularly appropriate time.

The year 1952 marks the 100th anniversary of professional engineering in the United States, as well as the anniversary of the founding of the American Society of Civil Engineers. In festive mood and with complete co-operation, professional engineers from all technical fields, and representing 65 engineering groups, participated in the convocation program. Members of these groups presented technical papers in their specialized fields, held conferences and symposia, or studied progress during the past century and took a look at the future of engineering in the United States.

High light of the convocation was Centennial Day on Wednesday, September 10. At luncheon that day, the Right Honorable Clarence D. Howe, '07, Canadian Minister of Trade and Commerce and Defense Production, was awarded the Hoover Medal.

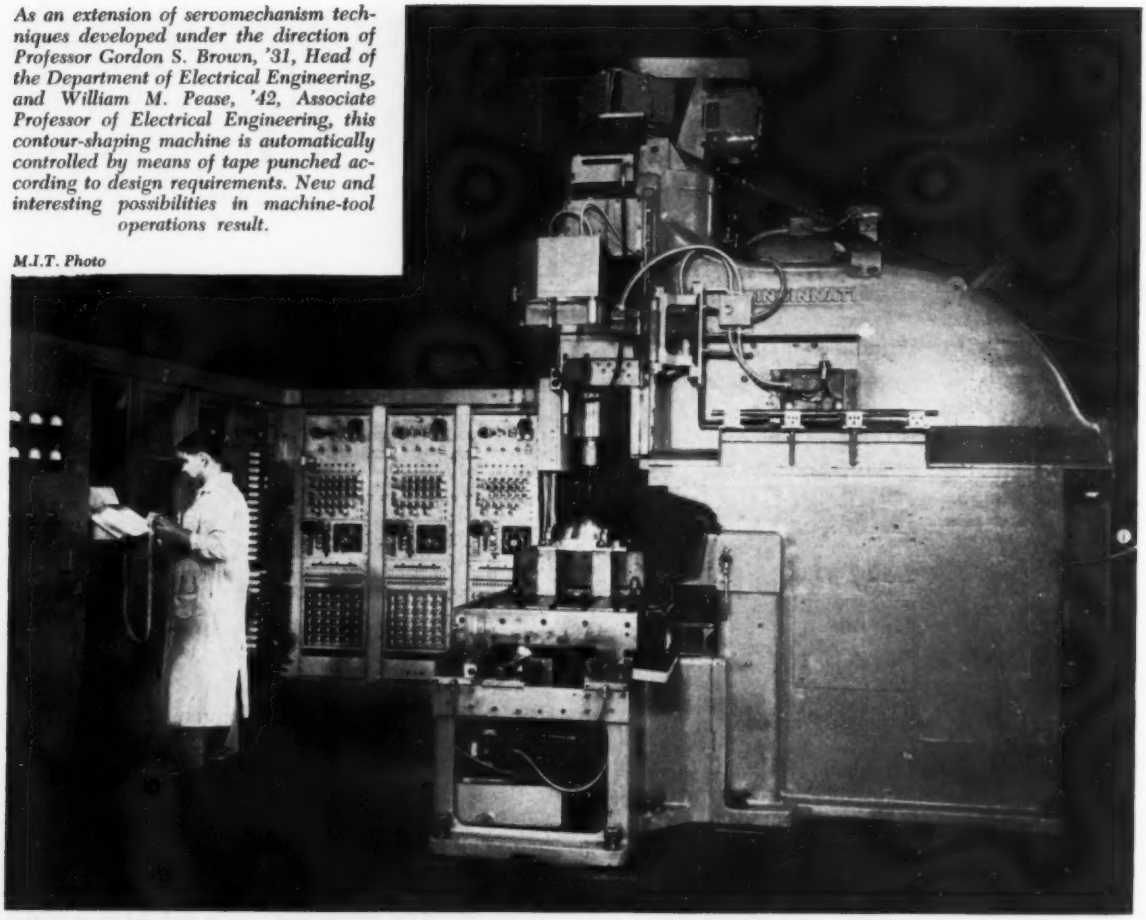
In accepting the Hoover Medal, Mr. Howe spoke of the new problems resulting from technological advances, and urged engineers to take an active part in attempting to solve problems which they have helped to create. In his acceptance address, Mr. Howe made the following comment: "The day is past when rule by a group of citizens trained in any one field can give satisfactory service to a nation in a complex world. The engineer's voice must be heard, and his presence felt . . . for he has something unique to contribute to the understanding of present-day problems." Former President Hoover was in attendance and spoke briefly in connection with the award named in his honor, which this year was bestowed upon a distinguished Technology Alumnus.

Appropriately enough, Technology Alumni and staff members participated in the Centennial program to a substantial extent in other ways as well. Harold L. Hazen, '24, Dean of the Graduate School, Milton C. Shaw, Associate Professor of Mechanical Engineering, and Professor Rolf Eliassen, '32, of the Department of Civil and Sanitary Engineering – all led discussion groups. In addition, papers on a wide range of technical and educational topics were presented by the following members of the Institute's Faculty and staff: Gordon S. Brown, '31, Nathan H. Cook, '50, Iain Finnie, '50, Robert J. Hansen, '48, Mayo D. Hersey, '09, Myle J. Holley, Jr., '39, Arthur T. Ippen, Warren K. Lewis, '05, Yao T. Li, '38, Egon Orowan, Bernard E. Proctor, '23, Ernest Rabinowicz, Milton C. Shaw, Maria Telkes, Walter C. Voss, '32, John B. Wilbur, '26, and Chin T. Yang.

On Tuesday evening, September 9, The M.I.T. Club of Chicago held a dinner commemorating the Centennial of Engineering. Under the able leadership of John G. Praetz, '28, President of the Club

As an extension of servomechanism techniques developed under the direction of Professor Gordon S. Brown, '31, Head of the Department of Electrical Engineering, and William M. Pease, '42, Associate Professor of Electrical Engineering, this contour-shaping machine is automatically controlled by means of tape punched according to design requirements. New and interesting possibilities in machine-tool operations result.

M.I.T. Photo



who planned the affair, the meeting provided an unusual opportunity for Technology Alumni to gather to discuss Institute matters as well as affairs of engineering interest. Donald P. Severance, '38, Secretary-Treasurer of the M.I.T. Alumni Association, represented that body and was one of 455 Technology Alumni present.

Additional plans for celebrating the Centennial of Engineering have been announced by the M.I.T. Club of Puerto Rico. This club plans a fiesta for mid-November to take special cognizance of the past 10 decades of professional engineering, and will be attended by H. E. Lobdell, '17, Executive Vice-president of the Alumni Association.

As granddaddy of the major engineering societies in the United States – and one of the earliest to operate anywhere in the world – the American Society of Civil Engineers has paved the way for other engineering organizations to make their contributions to our way of life in their own specialized fields. Its convocation brought into sharp focus the relative youth of engineering societies, and the vast contributions which engineering education has wrought by increasing our understanding of nature's laws.

As it begins its second century of service to the nation and to the engineering profession, the American Society of Civil Engineers has the wholehearted wishes for continued success from all in the broad field of technology.

Da Vinci's Science

THE scientific and engineering achievements of Leonardo da Vinci were brought to the attention of the Institute's Faculty and student body in an exhibition of models constructed by Roberto A. Guatelli from the drawings in da Vinci's notebooks. The exhibition, lent by the Fine Arts Department of International Business Machines Corporation, and displayed at the opening of the school year, commemorated the 500th anniversary of the birth of the medieval painter, sculptor, architect, scientist, and engineer extraordinary whose paintings, the "Mona Lisa" and "The Last Supper," have elicited international admiration for centuries.

In our present technological environment it is perhaps not easy to recapture and appreciate the intellectual atmosphere in which da Vinci lived, and to assess the contributions which his genius made possible prior to such thinkers and experimentalists as Descartes, Bacon, and Gilbert. That da Vinci's engineering achievements were not especially highly regarded until recent times is probably because none of his contemporaries had sufficient zeal and knowledge to follow in da Vinci's path; by the time his work received the attention due it, the intellectual climate had changed sufficiently so that da Vinci's work had lost its uniqueness. Today we reawaken to his engineering genius.

As indicated by models made from his sketches, many of Leonardo's conceptions are as practical now as when first conceived. This is true, for example, of his design for a scaling ladder which bears close resemblance to ladders now employed in fire fighting; of his circular pulley system which is essentially a multiple block and tackle system; of his two-level bridge with separate passageways for pedestrian and vehicular traffic; of his rack and pinion device for lifting heavy weights and which bears close resemblance to today's automobile jack.

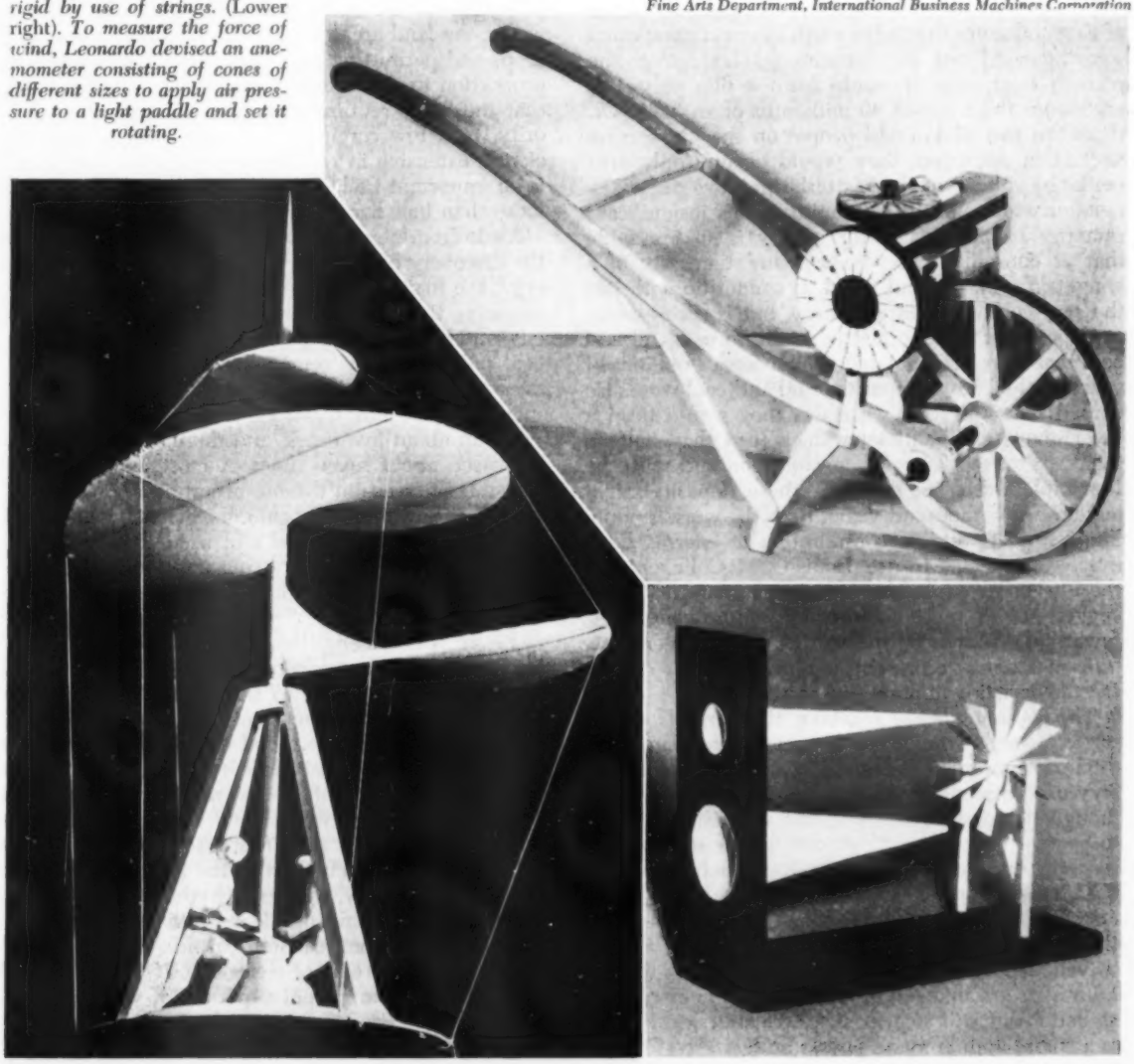
Other examples of da Vinci's outstanding engineering genius are shown in: his hydraulic pump which was erected to raise water for the Castle of Milan; his roller-bearing arrangement for reducing friction on turning axles; the air-conditioning unit built for the boudoir of Beatrice d'Este, wife of Leonardo's patron; and a printing press to be operated by one man. Other of da Vinci's practical inventions include: a variable speed drive; design for a clock with a minute hand as well as an hour hand; a grinding mill, and a nap-raising machine for brushing cloth. A hand-operated mint, designed by Leonardo, was used to cut metal discs and stamp out coins for the Papal State. He also devised a lens-grinding device, and a projector, with candle inside, for throwing an enlarged image of an object on a screen.

As examples of his work in military engineering, the exhibits show models of: a double-hulled ship to prevent, or at least to postpone, sinking; aerial bombs; a rotating bridge; a military tank designed for breech-loading cannon; a steam-activated cannon; and several designs of machine guns which greatly increased the firing power of arms of the Fifteenth Century.

Some of da Vinci's plans were destined for failure in application because the sources of energy available at his time were inadequate for the loads as-

Models of some of da Vinci's inventions are shown below. In the odometer (upper right) *dials turned by a system of gears, measured distances traversed as the large wheel was rolled along the ground.* (Lower left). *Scale model of aerial screw, heralding today's helicopter, and possibly a forerunner of the modern propeller, was to be operated by springs, or perhaps by man power. The light model is made more rigid by use of strings.* (Lower right). *To measure the force of wind, Leonardo devised an anemometer consisting of cones of different sizes to apply air pressure to a light paddle and set it rotating.*

Fine Arts Department, International Business Machines Corporation



signed to them. This is true, for example, of da Vinci's design for an ornithopter flying machine, the two huge wings of which were to be operated by human power through a series of ropes and pulleys, and a windlass. Da Vinci's study for a helicopter also falls in this class, although his air screw may well be the forerunner of the modern propeller.

Energy and Man

A SCALED, broad-gauge picture of the place of energy in man's present civilization, of the relative importance of the various fuels, and of the most likely development of energy sources in the future is the purpose of a group of papers recently released by United Nations Educational, Scientific and Cultural Organization. The six papers, by as many authors, are published by the U.N.E.S.C.O. under the general heading, "Energy in the Service of Man." This is not the place for a summary of an already compacted survey of the world's energy sources, but some of the points brought out are sufficiently striking to merit some repetition.

In a grisly but vivid illustration, Franz E. Simon of England notes that if the earth's human population were smeared out in a continuous layer over the planet's land area, it would form a film only .001 millimeter thick (about 40 millionths of an inch). Or, if all the two billion-odd people on the globe were packed in one mass, they would occupy only one-tenth the volume of the Matterhorn above the 3,000-meter contour. Yet, the appetite of this insignificant quantity of protoplasm for energy is so insatiable that it consumes every year many times its own weight in coal, oil, and wood. It cannot do with just the renewable sources of energy, but is eating away at deposits of organic matter in the form of oil and coal that were accumulated over scores of millions of years. If the known deposits of oil and coal were also spread over the earth's surface, they would form a layer about one centimeter thick (less than half an inch). At current rates of consumption and with the inevitable wastes in recovery, these deposits might last for a few thousand years. Both the world's population and its rate of consumption of energy, however, are expected to rise. Louis C. McCabe, chief of the Fuels and Explosives Division, Bureau of Mines, suggests that, unless something unforeseen arises, toward the year 2000 the world's annual energy requirements may represent as much as 1 per cent of the then existing mineral fuel reserves.

The radiant energy reaching the earth from the sun is scores of thousands of times more than man's total consumption of power. The amount of solar energy used directly by man is utterly insignificant. Although the kinetic energy in the winds is estimated to contain only about 2 per cent of the solar energy reaching the earth, the winds alone contain perhaps 2,000 times more energy than that obtained by man from fuels. But effective extraction of power from this variable, low-level source is difficult. A few wind-driven power plants, ranging in size from 100 to 1,000 kilowatts, are under construction, and numerous installations of still smaller size exist, but wind power is a trivial item in man's power budget.

For similar reasons, the energy in the tides is likewise unattractive for economic exploitation. Professor Simon points out that if half the money needed to develop the so-called Severn Barrage Scheme in Great Britain were spent in improving the efficiency of heating systems, it would save about 20 times more coal than would the tidal power plant.

One of the most easily exploited expressions of solar energy is water power, although the total available amount, even if fully developed, is not sufficient, apparently, to supply all of man's present energy needs. For the entire world, about one-tenth the potential water power has been developed, but the percentage in some countries is far higher. In Switzerland, full exploitation of the available economic sites is expected within perhaps two decades. That country is already drawing more than half her energy requirements from water, and the percentage is about as high or higher in Sweden, Italy, Norway, and Finland.

Plant growth also makes use of the sun's energy, although only about 1 per cent of the solar energy striking a given area is so converted. Wood and other plant growth are bulky and inefficient fuels. What is worse, the land area of the earth capable of growing crops and permitting easy harvesting is so limited in proportion to the human population's need for food, that the latter requirement must generally take priority. In a few countries, however, forests are sufficiently extensive in relation to population that wood is an important fuel. Finland is a case in point, with more than half her locomotives being wood burners.

Aside from new developments in nuclear power or the discovery of efficient means of utilizing solar energy, the main sources of energy for industrial man, for some time, will continue to be coal, oil, natural gas, and hydroelectric power. Since 1920, the world's coal production has remained virtually static. However, between 1920 and 1949, production of crude oil increased five times, output of hydroelectric power went up about five times, and the use of natural gas increased about seven times. A most important, but invisible, increase in the use of applied power arises from the slow but steady gain in efficiency with which power is being generated and used. In the United States, the ratio of energy consumption to gross national product has been declining at about 1 per cent per year.

Pierre Ailleret emphasizes that, however at variance with popular conception, electricity is rather a difficult form in which to transport energy. Almost invariably it is cheaper to move a high-grade fuel, such as petroleum or a good coal, to a power plant that has been erected close to its market than to build the power plant at the mine or oil field and transmit the electricity. This is not necessarily true for a comparatively poor fuel, such as lignite, however, where a power plant at the pit head might be preferable. Norway, with great hydroelectric capacity in relation to her needs, does not export electricity. Instead, she exports calcium carbide and aluminum, both heavy absorbers of electricity. It takes about 10 kilowatt-hours to refine a pound of aluminum. A pound of good coal contains only about one kilowatt-hour.

Partnership for Progress

Steady Advancement of Creative Enterprises Requires Teamwork of Industry, Government, and the Universities

By JAMES R. KILLIAN, JR.

THE role of applied science in determining the victors in World War II was a sharp reminder of the practical rewards that could come from energetic research and development programs. But even before this, the United States had been increasing its productivity on the average of 3 per cent a year through ever increasing mechanization of industry. From 1939 to 1950 industry in the United States increased its use of power 134 per cent. Today American industry produces one-half of the world's goods with only 7 per cent of the world's population, and we are just at the beginning of a new era of automatic control as applied to industrial processes. One of the most recent extensions of automatic control is the development of a milling machine that operates in response to instructions that are typed out on tape and inserted into the machine.

The growth of expenditures for research and development has risen rapidly during the past decade, with government assuming the predominant financial support. The bar at the extreme right shows the extent to which the universities, industry, and government conduct the nation's research during 1952.

In 1915 there were about 100 research laboratories in the United States. Today there are 3,300 and they employ 165,000 people. Since World War II the federal government has greatly expanded its research activities, and this year it is spending more on research than industry and the universities combined.

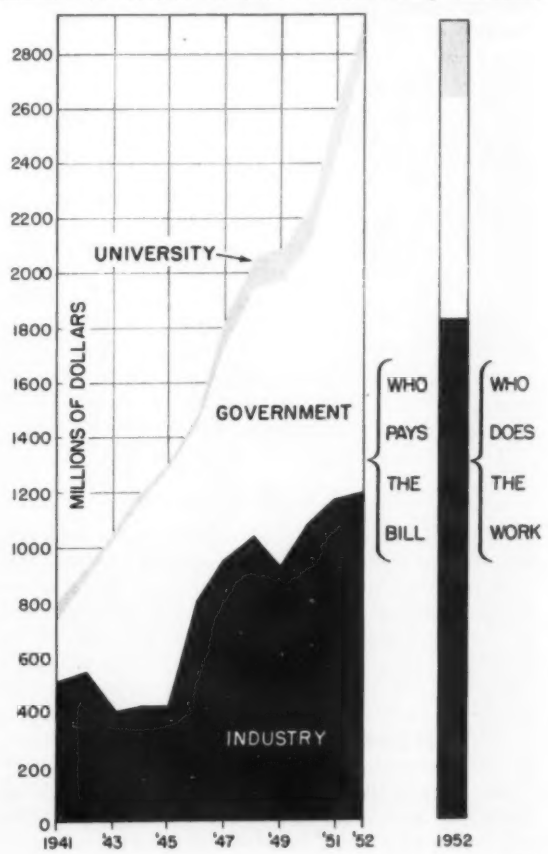
In the past two decades, research expenditures in this country have multiplied more than tenfold, and today the nation is spending three billion dollars on research. That is a sum almost as large as the total federal budget 25 years ago. It is equal to about 1 per cent of the national product at the present time. Putting it another way, this huge total represents an expenditure per man, woman, and child of $20 a year.

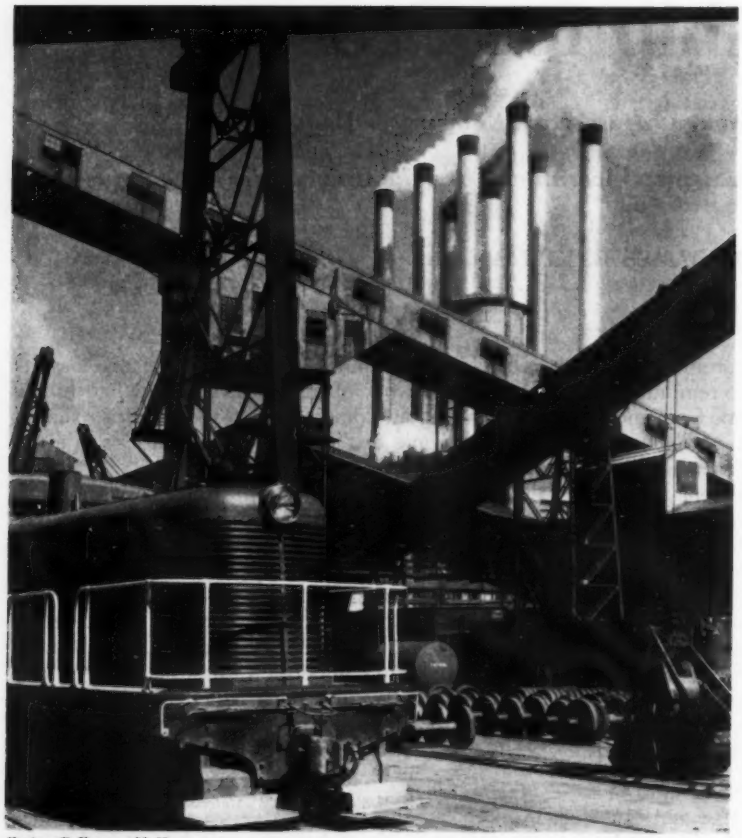
Our industrial expansion is unprecedented. By the end of this year, 50 per cent will have been added to industrial capacity since 1945, the largest relative gains having been made in electrical machinery, nonelectrical machinery, and chemicals. And these new highs in total investment represent also more investment per worker. A study of 100 of the country's largest manufacturing enterprises revealed that in 1949 the total assets of the companies represented an average investment of $12,200 for every worker, of which $5,400 was in the form of plant and equipment. In many industries the investment per worker was much higher than this average.

Because this rapid technological advance has its effect on the work of all of us, I should like to say something about some of the responsibilities shared by industry and our educational institutions in a period like the present.

First of all, of course, we must do everything possible to increase the number of engineers and scientists. Since 1890 the number of engineers has increased tenfold in industries that have increased threefold. Today we have approximately 400,000 engineers employed in industry, and engineering has become the largest profession for men. Despite this, the shortage is acute. Industry competition for engineering graduates in June, 1952, has been called hysterical – and

Resources for Freedom – *President's Materials Policy Commission*





Ewing Galloway, N. Y.

There is opportunity in an academic environment to draw upon the resources of technology and of the social sciences in studying the methods of operating our increasingly complex technological industries.

not without reason. Never before in history have the engineering graduates had so many jobs to choose from or been offered so many inducements to join a particular company. Yet the number of engineering students entering college declined sharply after reaching a postwar high that produced 50,000 engineering graduates in 1950. Last year the number had fallen to 40,000. This year the number of graduates was less than 30,000, and the number will decrease for the next two years. In the fall of 1951, freshman enrollments showed a reversal of this trend, but even at best the shortage of engineers will be serious for many years. We must do everything we can to interest more young people in seeking engineering careers.

Industry's Stake in Education

I suggest that industry has a stake in making sure that enough first-rate young people move into these fields and that it can help in bringing to the attention of the American public industry's need for scientists and engineers and the opportunities which are available. Happily, industry already has begun to help notably in those areas where the shortages are most acute – in electronics, aeronautics, and chemistry.

There has been a steady increase in the number of fellowships and scholarships provided by industry. While most of these have been at the graduate level, there has been an increasing number of industrial scholarships provided for undergraduate study. One of the most interesting plans for doing this is that developed by groups of industries, as for example, by the American Foundrymen's Association. Here, the wise decision was made that the best way of interesting more students in the foundry industry was not to promote highly specialized courses of study relating to foundry practice. Instead, the interest of young people was stimulated by giving them scholarships which involved only the obligation to work in a foundry during some summer. There was no obligation to take a job after graduation in the industry. This plan has worked with great effectiveness to start the flow of a highly trained group of young men into an industry that fully realized that it could benefit from a greater number of first-rate engineers. I cite this as an example of an effective program of industry-education collaboration.

Another problem which industry and education must face today is that of making sure that, as the nation increases its research and development expenditures, it does not dry up the wellsprings of our scientific advance by drawing too many scientists into development work at the expense of basic science.

I have spoken already of the total expenditures for research in the United States. It is interesting to look at the sources of the funds as reported by the President's Materials Policy Commission. Of the three-billion-dollar total, about 55 per cent is being paid for by government, 40 per cent by industry, and 5 per cent by universities and other nonprofit institutions. This distribution has markedly changed over the last 10 years, for in 1942 the government's share was only 35 per cent, industry's share was 60 per cent, and the universities' and nonprofit institutions' share was again 5 per cent. The 1952 figures, of course, reflect the great expenditures by the government for defense research, but the significant fact that remains is that the government has become the chief agency for initiating and financing research.

Several other observations can be made about this distribution of the research dollar. Some 95 per cent of the total spent goes for development research. This, of course, is a roughest kind of figure, representing as it does a total of the expenditures by government and industry. Of course, in their laboratory activities, both the government and industry undertake some basic,

fundamental research. It is proper that the primary interest of industry and government research programs should be the development of new products, new methods, and new military strength. The interesting thing, however, is that the amount spent by the universities (5 per cent of the total) is as low as it is. This 5 per cent may be presumed to represent the budget for our pure research activities.

Twenty years ago, 15 per cent of the nation's total research expenditures came from funds possessed by the universities. To a considerable extent these were funds that permitted free and uninhibited use. Today, with the universities expending only 5 per cent of the national total, we can only conclude that there has been some reduction in the availability of free funds, even though the total expenditures of the universities have increased.

I have been expressing in terms of dollars expended a problem that has long been recognized as having serious import for our country. While giving strong support to development and application, we have not yet properly provided for pure and fundamental research, the seedbed of all development and application. It has almost become a cliché to say that we have imported our fundamental scientific ideas from outside the boundaries of the United States. This is not altogether true, but there is enough truth in it to drive home the importance of giving adequate attention to the wellspring of our nation's science and technology.

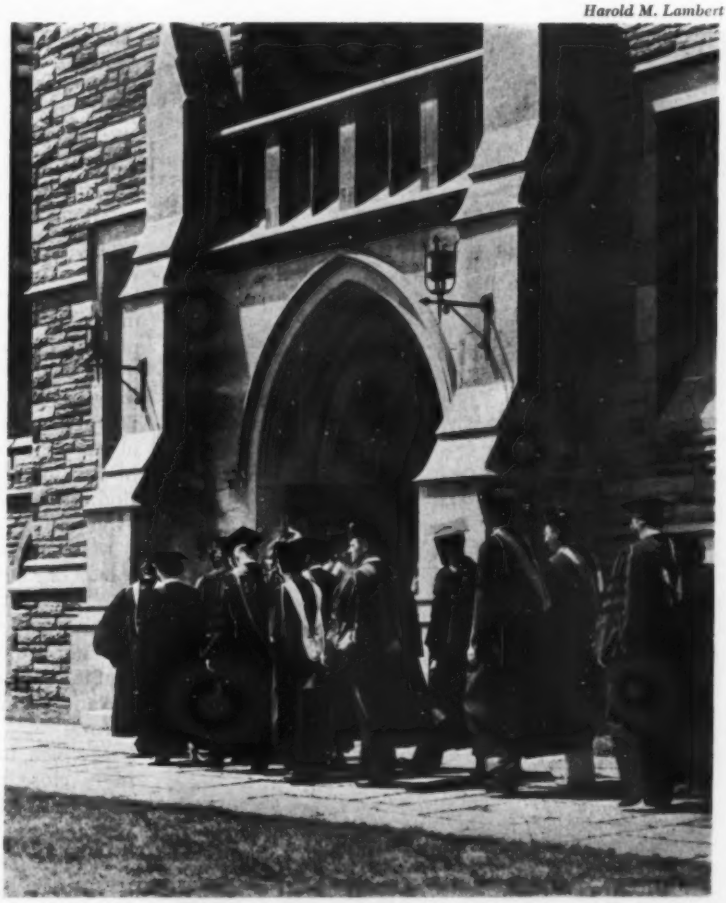
The encouragement and support of basic research must be brought about through joint action on the part of the universities, industry, and government. Let me speak particularly about the partnership responsibilities of industry and the universities.

Believing that there is much to be gained through cross-fertilization of ideas, especially in the field of science and technology, I have long been an advocate of close relationships between education and industry. I believe, for example, that it is of an enormous value to an institute of technology for its faculty to be intimately informed about the problems and the methods of industry. I also believe it important for industry to be informed about the problems and the methods of education and basic research in their fields of interest.

One hazard in bringing about this close relationship is that it will tend to divert the interest of the faculties in the universities from their primary preoccupation with education and basic, uncommitted research. There is no need for this happening, however, if there is a clear understanding of the proper function of the university on the one hand and the proper function of industry on the other in the field of research. It has been very heartening to me in my many contacts with industry to see how widespread is the feeling among industrialists that the university must not be diverted into the kind of development work which is the special responsibility of industry and which industry can do best.

This point of view is all the more important since industry is more and more supporting research in our educational institutions. Through the provision of fellowships, grants-in-aid, and other methods of support, industry is making it possible for our privately financed and endowed institutions to survive the debilitating disease of inflation. I suggest that this is a heartening healthy situation, that it is free enterprise supporting free enterprise, provided we make sure that the universities protect and extend their preoccupation with basic research and education. It is this basic research and education that will provide the ideas out of which development research and new products can be carried out tomorrow.

Harold M. Lambert



Basic to everything we do, of course, is the availability of effective man power.

It must be said that, in a period when the national security is in danger, preparedness requires some diversion from basic research on the part of all of our institutions, both educational and industrial. We know that in World War II and during the present period, our universities have been called upon to do extensive applied research. This they must do in the national interest, but the necessity for doing it only points up the importance of stressing the protection of their basic research activities.

Effective Man Power Needed

Basic to everything we do, of course, is the availability of effective man power. It is a striking fact that 70,000 scientists and 55,000 engineers, or a total of 125,000 men and women, carry the research load of the United States. Of this total, about 60 per cent are in private industry, 33 per cent in government, and about 7 per cent in universities and nonprofit institutions. This is an exceedingly small fraction of our total working population, and its smallness points up the importance first of preserving an atmosphere and environment in which this group can be most effective, and second, of making sure that we maintain a steady flow of first-rate minds to the group. Of this total of 125,000 research personnel, only about 9,000 are in our universities and hospitals. This is the group that has the responsibility of carrying on our basic research and of making sure that we are training new men highly competent to do research. It is important that we provide the best possible conditions for this handful of men to carry out their work effectively.

A. J. Baker

The interest of young people was stimulated by giving them scholarships . . . to start the flow of a highly trained group of young men into an industry that fully realized that it could benefit from a greater number of first-rate engineers.

Engineers Become Executives

So far I have spoken mainly of joint industry-educational programs to further technological innovation. Let me conclude with some observations on the equally important opportunity to develop innovation in the field of management.

Some time ago we had in this country a team of educators and industrialists from England, brought over under the auspices of the Economic Cooperation Administration to study education-management relationships in this country. The report which they rendered their associates in England was very interesting. They pointed out, for example, how much more extensive is our education in engineering in this country than engineering education in England and how greatly this had affected our technological advance. They further pointed out the growing emphasis in the United States on preparation for management responsibility which apparently has no parallel in England or in any other country for that matter. In England it has been an exceedingly unusual thing for a man trained in science and engineering ever to move into a position of executive responsibility. In this country it is becoming increasingly true that engineers are coming to play a predominant role in management.

In the United States there has been a steady increase in the scope and size of our schools of management, although up until this point their primary emphasis has been on teaching rather than research. With the impetus coming from men in industry, such as Alfred P. Sloan, Jr., '95, a greater interest is now developing in the opportunities for innovation in management techniques. There is opportunity in an academic environment to draw upon the resources of technology and of the social sciences in studying the methods of operating our increasingly complex technological industries.

Here we see the teamwork that has been traditional in our industrial society, being strengthened through new concepts in research techniques. The full impact of this development on our industrial life has still to be felt, just as we are only at the beginning of the period of technological advance which the present high expenditures on research promise to make possible.

Many factors will combine to help determine the rate of our advance in the years ahead. Excessive taxation, or taxation that does not recognize the importance of expenditures for research could seriously retard our progress. Inflation is still a hazard. But I think that it is safe to assume that the years ahead will bring advances more extensive and more rapid than ever before.

My plea, in conclusion and summary, is for increasingly close relationships between industry, government, and education, in order to insure that the best possible environment and conditions are maintained to enable research and development and creative enterprise steadily to move ahead.

No Virtue Goes with Size

Victim of Modern Technology Is the Outsize Man Whose Clothing, Housing, Transportation, and Even Occupation Are Affected by the Economics of Mass Production Techniques

By FREDERIC W. NORDSIEK

A RECENT news item* tells of a midshipman who, during his residence at Annapolis, grew from six feet two inches tall to six feet five inches in height. Thus he became an inch too tall to qualify for a commission in the United States Navy. This account emphasizes the small range of size expected of men in general, and indeed required of military men.

By conforming to narrow size limits, the human being qualifies as an animal, according to one part of the sixfold definition which biologists use to distinguish animals from plants† This definition states that animals, in contradistinction to plants, are capable of spontaneous movement, show rapid motor response to stimulation, possess sensory and nervous organs, do not contain cellulose or chlorophyll, are not capable of photosynthesis, and are strictly limited in size and form.

With respect to the latter phase of this definition, a normal tree, for example, continues to increase in size as long as it survives. It has an indeterminate number of limbs, arranged in manifold ways. Shapes of trunks, and general configurations of trees, vary widely. In contrast, the body framework of the normal human being stops growing at the end of adolescence. Furthermore, like all higher animals, men have a fixed number and arrangement of extremities, and a highly standardized form.

The normal size range of human beings could be established by citing some of the voluminous statistics available on the height and weight distributions of various human groups. But this point can be made just as firmly by merely recognizing that in the everyday American lexicon, a human male less than five and a half feet in height is "short," whereas one over six feet high is "tall." Hence a mere six inches is generally acknowledged as the range of *usual* size.

What, then, is the fate of the outsize man? The military answers this problem by ruthless exclusion. The mighty midshipman whose plight was recounted at the opening of this article might have qualified for a commission in the Army or the Air Force if he grew no taller than six and a half feet. Should he grow taller than that, none of the armed services would have commissioned him. The Navy sets a height limit two inches shorter than the other services, presumably because of the cramped quarters aboard ship. Such a restriction makes sense to any fairly tall man who has battered his head while moving about below decks on a naval vessel, or even on a civilian ship not in the luxury-liner class.

But a much more important reason behind exclusion of outsize men by the armed forces is clothing supply. For when the range of apparel sizes kept in stock by military storerooms is extended the least bit, difficulties in logistics become disproportionately exaggerated.

The fact that the armed forces have no use for outsize men, irrespective of whether they are tiny or huge, underlines the extent to which hand-to-hand combat has disappeared from modern warfare. In ancient times, immense soldiers were highly prized, but today the armed forces exclude giants just as uncompromisingly as they debar midgets.

Though excluded by the sartorial designers for those assigned to the modern planet of Mars (be it Korea or Europe), the outsize man must literally "fit in" to civilian life on our wordly planet. He must squeeze through doorways, hunch into chairs, curl up in beds, and wriggle into his clothes. Fortunate indeed he is if he can afford to have his clothes made to order. (An acquaintance of the writer's, who is both tall and obese, but fortunately is well to do, once remarked that the only item of apparel he could buy ready-made was a handkerchief.) But most men must clothe themselves from ready-made stocks.

An important reason behind the exclusion of outsize men by the armed forces is clothing supply.
Ewing Galloway, N.Y.

* "Tall Story," *Newsweek*, April 30, 1951, page 40.
† "Animal, Vegetable," The Technology Review, **52**:425 (June, 1950).

Ewing Galloway, N.Y.

The matter of clothing sizes may be made tangible by considering the sizes normally stocked by retail distributors.

Let us ponder this question of clothing. Incidentally, such a review brings to light some curious lore concerning the measurement and designation of apparel sizes. We shall confine ourselves principally to men's clothing, with occasional brief excursions to the distaff side to provide amusing contrast.

Clothed with Integrity

Human apparel, one quickly realizes upon considering the question of sizes, falls into two discrete groups with respect to variability in size. One group, with relatively narrow variation in absolute size, includes hats, gloves, and shoes. The other, having substantial size ranges, includes trousers, coats, and underwear.

The key to this difference in size variability is the area of the body which each apparel group covers. Hats, shoes, and gloves must fit the head, feet, and hands – in short, the extremities. These locations, for some unknown biological reason, are little subject to the accumulation of fatty tissue which characterizes obesity. Therefore, their size is determined mainly by the bony framework and musculature of the body, and, as a result, fulfills the criterion of narrow size limits laid down by our basic definition of animals.

Trousers, coats, and underwear – to the contrary – cover portions of the *trunk*. And it is here that obesity, a phenomenon limited in nature to man and certain of his domestic animals, occurs. There is no limit to the accumulation of fatty tissue. Therefore the trunk of the human body, and the clothing that covers it, do not conform to the natural law limiting the usual sizes of the animal body framework.

The matter of clothing sizes may be made tangible by considering the sizes normally stocked by retail distributors. Certain specialty shops, to be sure, cater to outsize customers. But a more representative picture will be obtained if we take our data from the catalogue of one of this country's major mail order houses.‡‡ Such a source of information affords an excellent measure of *usual* sizes, for the range carried has been worked out over decades of experience. It strikes a happy balance of satisfying the needs of as many people as possible, without unduly complicating catalogues and cluttering stock-room shelves with sizes asked for by relatively few customers. In the following discussion, the statement, that a given apparel item *is available* in certain sizes, applies to the stocks of a typical American mail order house.

‡‡ *Montgomery Ward*, Fall and Winter, 1950–1951.

Head, Hand, and Foot

Men's hats are stocked in sizes from 6⅞ to 7½, with increments of one-eighth size. The reader has doubtless purchased and worn such headgear throughout his adult life; but does he know what the sizes signify? If a hat were to be ordered by mail, and the size were unknown, how might it be found? Very simply! With a tape measure determine the perimeter of the head, in inches, at the level where the sweatband of the hat will rest; then apply the formula:

$$\text{hat size} = \text{perimeter of head} / 3.1416$$

In short, sizes of men's hats are the same as the mean diameter of the head, measured in inches. Thus, hat size represents the diameter of a circle whose circumference is equal to the perimeter of the head. Hence, the usual limit of men's hat sizes (from 6⅞ to 7½) represents head circumferences of 21 to 24 inches, a range of only three inches. From a mean value of 22⅜ inches, the usual extremes do not vary more than about 13 per cent. The ladies, ever more forthright, determine their hat sizes directly in inches of head perimeter.

Although men's hat sizes, in contrast to women's, are determined by a recondite formula, just the reverse is true of gloves. The sizes of men's gloves are measured directly in inches, whereas this is not true for women's hand coverings. Men's glove sizes are specified in terms of the perimeter of the hand at the knuckle, measured to the nearest half inch. The sizes of women's gloves are determined in the same manner, except that three-fourths of an inch is subtracted from the measurement. This system perhaps fosters a feeling of feminine manual daintiness; for if a pair of spouses had exactly the same hand size and the man wore size 8, the woman would take a mere 7¼.

Men's gloves are stocked in sizes 8 to 11. The usual variation from the mean of 9½ is three inches, or about 32 per cent. Since graduation in half sizes is the rule, seven sizes are usually provided to cover the range. But one mail order house finds it feasible to bridge the span with but three sizes in dress gloves for men – small, medium, and large. Men's work gloves, where utility is the sole consideration and appearance inconsequential, come in one size only.

The high uniformity in size of the human hand is confirmed by our observations that the total range in perimeter at the knuckle is but three inches, and that the majority of male hands are provided for with, at most, seven and sometimes as few as three sizes for dress gloves, and one size for work gloves.

In footgear we encounter the most remarkable of the several systems of size designation used for human apparel. A size in shoe length is one-third inch. Men's shoes are made in half sizes from 7 to 12,

corresponding to shoe lengths of from 9⅔ to 11⅙ inches. In width, a size is one-sixth of an inch. When the system was established, it was assumed apparently that the human foot was never narrower at the ball of the foot than three and a half inches, never broader than four and one-sixth inches, for the sizes *A* to *E* were set to cover this range. Subsequently *AA* and *AAA* were created to cover feet progressively narrower than *A*, and widths *EE* and *EEE* to take care of feet wider than *E*.

Just to complicate the picture and to prevent sock sizes from corresponding directly to shoe sizes, hose sizes are measured in inches according to the length from toe to heel when socks are laid out flat and no size is given for foot width. Sizes 10 to 13 are provided. Naturally the sock is somewhat shorter with a foot inside, but just how much shorter depends upon the width of the foot. Also, the soft and elastic nature of hose, and differences in personal preferences as to looseness or snugness of fit, permit considerable latitude in choice of sock size. That is why a three-inch range in length of socks is provided, whereas the range in shoe lengths is less than two inches. Hence, it is the rigid shoe that we must take as our measure of usual variability in size of the human foot. The range of shoe size 7 to size 12 provides for a variability of foot length of only one and two-thirds inches; between widths of *A* and of *E* there is a range of two-thirds of an inch.

The Trunk Line

Now we arrive at the clothing that covers the trunk of the body and hence must encompass possible obesity as well as fundamental frame size. So far as men's clothing is concerned, we leave behind at this point most of the esoteric sizing systems. For, with one exception – pajamas – men's clothing worn on the trunk is measured in inches.

A consideration of trousers provides a logical transition here. One dimension of trousers, the inseam, is determined by body frame size; whereas the other, the waistline, is affected by obesity if present. The inseam is the length of the seam from crotch to end of the leg. Trousers are provided with inseams whose lengths range from 29 to 36 inches. In contrast, waist sizes go from 30 to 44 inches. Thus the inseam has a range of seven inches against a waistline variation twice as great.

When furnished as part of a suit, trousers are made in a median waistline size approximately corresponding to that of the coat, and are altered as necessary. Hence suit sizes are, in fact, coat sizes which represent the perimeter of the chest, in inches. The range provided is 36 to 44 inches. This range is smaller than that of the trouser waistline, emphasizing the fact that the male chest is less subject than the abdomen to accumulation of fat.

Like coats, undershirts and pajamas are provided in chest sizes from 36 to 44 inches. Undershirts are measured directly in inches: in recognition of the casual appearance acceptable in the privacy of the bedchamber, pajamas are made in only four sizes, lettered *A* to *D*, to cover the same range.

Undershorts are made in waist sizes 30 to 44, the same as trousers. Union suit underwear introduces a new dimension, cleverly contrived to give a combined indication of body frame size and possible obesity. This is *trunk* size, in inches, determined by running a tape measure over one shoulder and through the crotch. Union suits are provided in trunk sizes of 58 to 74 inches, a range two inches greater than that of trouser waistlines.

H. Armstrong Roberts

MEN'S APPAREL

Size Range in Mail Order Catalogue

Item	*Quantity Measured*	*Smallest Size (Inches) S*	*Largest Size (Inches) L*	*Mean Size (Inches) M=½(L+S)*	*Absolute Range (Inches) R=(L−S)*
A. Worn on the Extremities					
Hats	Perimeter of head	21	24	22½	3
Gloves	Perimeter of hand at knuckle	8	11	9½	3
Socks	Length of foot, flat	10	13	11½	3
Shoes	Length of foot	9½	11⅙	10⅓	1⅔
	Width of foot	3½	4⅙	3⅝	⅔
B. Worn on the Trunk					
Coats and Undershirts	Perimeter of chest	36	44	40	8
Trousers	Perimeter of waistline	30	44	37	14
	Length of inseam	29	36	32½	7
Shorts	Perimeter of waistline	30	44	37	14
Underwear	Trunk	58	74	66	16

Ewing Galloway, N.Y.

In footgear we encounter the most remarkable of the several systems of size designations used for human apparel.

In recapitulation, then, we see that apparel worn on areas where fat rarely accumulates has size ranges of but a few inches. Where obesity is provided for, as in waist or trunk measurement, the range is as great as 16 inches. Hence the data on clothing sizes show the human organism, barring obesity, to be highly uniform in size.

Think No Bed Too Narrow

Furniture is a part of man's physical environment that needs to fit him much less intimately than clothing. Thus everyone is expected to adapt himself to chairs which have seats 18 inches from the floor; for this is the seat height of the standard straight chair. As a result, when seated, short persons may find that their feet do not quite touch the floor. Conversely, people who are at all taller than average can achieve comfort in the standard chair only by sprawling their legs well out in front.

Beds are also made in standard sizes. Here, though, short people have no trouble; they simply leave the lower portions of their beds vacant. But pity the tall man where sleep is concerned! Standard mattresses are 74 inches long, leaving a 72-inch man precious little room for his pillow. In his own home he may provide himself with a special 80-inch mattress and a bed to hold it: these are available from stock but anything longer has to be made to order. Away from home the tall man can only hope to find a wide bed and sleep crosswise.

In theaters, trains, busses, and airplanes the displacement of the human body has significance transcending considerations of mere comfort. For the number of bodies that may be crammed into a given space determines the pay load, and hence the income of theaters and transportation operators. The degree of squeezing which the customers will endure in such situations seems to be inversely related to the time they have to spend there. This relationship is neatly demonstrated by the capacities of railroad passenger cars of various types.

The standard Pullman, or first-class railroad chair, car seats some 30 people, riding two abreast. Coaches used for long runs, with seats far enough apart so that they may be turned down into a reclining position but with four seats abreast, hold twice as many passengers.

But coaches recently designed for commuter runs, and made with *five* seats abreast, accommodate 130 seated passengers! Thus from 30 to 130 human bodies in the seated position can be considered to be the capacity load for a railway car. Apparently, for all his uniform size, the human being is extraordinarily compressible.

In earlier days, when man depended upon physical prowess much more than is now commonplace, physical size had its virtues. Outsize men were prized for warfare as well as for their general strength and assumed physical endurance. When each family or small group of individuals was essentially a self-contained unit, the disadvantages of deviating from the norm were of little consequence. Today, however, a technological society depends very heavily indeed upon a degree of standardization which applies as readily, and as ruthlessly, to the human being as to the manufactured article. In striving toward the average, or mean, value, certainly no virtue goes with size.

Ewing Galloway, N.Y.

Clothing that covers the trunk of the body . . . must encompass possible obesity as well as fundamental frame size.

Biological Warfare —Menace or Myth?

A Distinct Possibility in the Hands of a Malefic Enemy, Germ Warfare Is Less Threatening Than Some Allege. Its Baleful Effects Can Be Minimized by Preparedness

By JAMES A. TOBEY

On November 4, 1941, about a month before their treacherous attack on Pearl Harbor, the Japanese bombed Changteh in the province of Hunan. At the time, this military action did not seem to be unduly significant, and yet certain of its baleful and noxious effects are being felt throughout the world today, more than a decade later.

Shortly after this ardent bombardment in 1941 there broke out, in the Chinese province of Hunan, a severe epidemic of bubonic plague. This terrible disease, known in history as the Black Death, has been, and is, a frequent and often violent visitor in many parts of China, but it had not been seen in Hunan for a number of years.

The Chinese promptly decided that the bombing and the pestilence were more than a mere coincidence. In March, 1942, Wang Shih-chich, the Chinese Minister of Information, vehemently accused the Japanese of having deliberately employed germ warfare in Hunan. He stated that he possessed irrefutable proof, obtained after exhaustive investigation, that the odious Japs had dropped plague-infected materials in porcelain bombs which had been manufactured in Manchuria, and that these were the real source of the lethal outbreak in Hunan.

If this allegation be true, the incident represents the first substantial and successful use of biological warfare in history. There is, however, no conclusive evidence to prove that it is true.

It is now well established that the Japanese, like the Americans, the British, the Germans, and the Russians, had been considering and experimenting with germ warfare as early as 1941. In the Hunan episode, nevertheless, the Chinese never were able to produce any actual bacilli from the objects used in the bombing. The accusers also seem to have overlooked the undeniable scientific fact that bubonic plague is disseminated naturally to man only by certain types of fleas carried by plague-infected rats. In the field, this disease never has been spread to man by infected grains, bits of cloth, or other fomites.

Now comes the dramatic sequel to this Hunan story. Some 10 years after the incident the Chinese Communists had come into possession of the files of the erstwhile Nationalist Ministry of Information. In culling over this material, a shrewd and sinister Red propagandist evidently came across the vivid reports of the Hunan affair. Here he found grist for the usual malicious and hypocritical Communist propaganda mills. Late in 1951 Peiping fraudulently accused the "American Imperialists" of employing germ warfare in North Korea. In this area, and in Manchuria, the plague has been rampant, due to war conditions and the inefficiency of the Chinese Communists in sanitary matters.

This first canard of the Communists did not attract much attention. A year ago it was a cloud no bigger than a man's hand, but in the course of time it has become a big, black cloud, tinged with red.

Early in 1952 a vigorous and vicious campaign to spread the false charges, that germ warfare had been employed by United Nations forces in Korea, was launched by the Chinese and Russian Communists. By sheer force of constant and loud repetition this fatuous lie has grown in volume and, to a limited extent, in influence. This absurd accusation has, of course, been denied by responsible American officials, and it is further discredited by the fact that the Russians, through the ineffable Yakov A. Malik, have vetoed all proposals for impartial investigations of the facts by neutral scientific organizations, such as the International Red Cross and the World Health Organization.

As a matter of fact the Soviet Union itself has been suspected and even accused of using biological warfare. In 1947 an epidemic of cholera broke out in Egypt, where this deadly disease had not occurred in epidemic form for about half a century. Before the outbreak was controlled, with aid from the American-supported World Health Organization, it had caused some 20,000 cases and many thousands of deaths. In our own country the charge was made by certain irresponsible commentators that: (1) the Russians had been working on germ warfare, and (2) there was something highly suspicious about this cholera epidemic in Egypt. Actually, evidence to support this innuendo is no better than in the case of the Hunan affair. The cholera was imported from India, where it is endemic, and it is unlikely that the Russians were involved in any way, even though it may be conceded that they are morally and scientifically capable of such a crime.

Neither bubonic plague nor Asiatic cholera is particularly well adapted for widespread biological warfare, although cholera could be employed by saboteurs in domestic water and food supplies. It is said that, in World War I, the Germans attempted to spread cholera in Italy, but without any appreciable success. In that war German saboteurs managed to infect a few American army horses with glanders, but

this was a relatively crude and trivial event in the annals of biological warfare. So far as is known, this method of unconventional warfare was not attempted during World War II.

The intentional use of pathogenic organisms to harm an enemy is a possibility in the future, nevertheless, which it would be folly to ignore. Among the many hundreds of disease-producing micro-organisms are at least a score of viruses, bacteria, rickettsiae, parasites, fungi, and their toxic products which are particularly well suited for germ warfare on an extensive scale against man, animals, and plants; what is equally important, the means to use them have been developed. When we are confronted by an unscrupulous, amoral, and barbaric enemy, biological warfare affecting civilians as well as the military is a contingency for which we must be adequately prepared.

The United States is ready to meet this exigency, although our preparations could be improved in certain respects. This country has been alert to the possibilities or probabilities of biological warfare since 1941, although extensive and effective research on the problem was not begun until 1944. Official investigations, concerned with both the offensive and the defensive aspects of the subjects, are under the aegis of the Chemical Corps of the United States Army, with the advice and assistance of the Surgeon General. The work is being conducted by several thousand qualified scientists at a large military installation in the East and at proving grounds in the West; many noteworthy results have been achieved, some of which have been published, and some of which remain veiled in the shroud of secrecy.

Experts who have been studying this important matter know a great deal about biological warfare, but their information seeps slowly to the general public and to the workers in the field who may have to cope directly with such warfare if it occurs. Literature on the subject has been issued by the Federal Civil Defense Administration, Washington, D.C.* and deserves perusal by all concerned, which is everyone. Unlike the moderate tone of this material, some of the newspaper stories on this topic have been highly sensational and exaggerated.

In broad outline the essentials of biological warfare are not difficult to comprehend. But an understanding of such matters, on the part of the public, can do much to build up resistance to, and alleviate the effects of, biological hazards should they be employed by our enemies.

Biological warfare, if employed against us, could be launched in several ways. Dangerous germs could be sprayed in clouds over our large population centers by hostile aircraft or submarines equipped with special devices for this nefarious purpose. Pathogenic materials could be introduced into domestic water and food supplies, into air-conditioning systems in large public buildings, and in numerous other ways by a legion of saboteurs and fifth columnists, who are probably organized and ready for this task when the time comes.

Enemy aircraft and submarines would have to penetrate our antiaircraft and coastal defenses, of course, a feat which is not as simple today as it was at the times of the sneak attacks by the Japanese on Pearl Harbor and of the Germans on Bari in Italy in 1944. If the hostile craft managed to get through, they could release aerosol bombs from considerable distances, each packed with millions of deadly germs, mixed with suitable powders to help carry them to the victims on the ground.

The success of such an attack would depend upon a number of factors, including the nature and stability of the organisms, the height or distance at which they were released, the atmospheric conditions at the time, the vigilance of our civil defense and public health authorities, and the state of preparedness of the public itself. In any event, such a biological warfare attack definitely would not cause the immediate deaths of large numbers of persons, no matter how favorable to our enemy were the conditions.

The first line of defense against biological warfare is the prevention of massive attacks and actions by saboteurs; this is a responsibility of our military and security agencies.

Boeing Airplane Company

* *Health Services and Special Weapons Defense*, Federal C.D.A. Publication No. AG-11-1, 1950.

What You Should Know About Biological Warfare, Federal C.D.A. Publication No. PA-2, 1951.

At best only a fraction of the biological agents thus disseminated by an enemy would reach the intended victims, and only a fraction of the persons exposed would succumb to the disease or diseases. Of course, these fractions might be large or small, according to the circumstances in the particular case, but in any massive biological warfare attack there is bound to be a large amount of waste. Some of the germs are lost in the explosion, others are dispersed by wind and rain, some may be rendered innocuous by sunlight and dryness, and many would fall upon fallow ground. Most microbes perish quickly when deprived of the warmth and nurture of living hosts such as man, animals, birds, and insects.

If the germs reached the population and were breathed in or swallowed by a considerable number of persons, only those who were susceptible and not immune to the maladies would contract them, and after an interval of time, known as the incubation period, would display the symptoms. If unrecognized or unchecked these diseases might spread to others and become epidemic, causing many cases and some fatalities. There is no reason, however, why any disease thus spread should not be quickly recognized and adequately controlled in this country.

A resourceful enemy probably would use not one but several pathogens in biological warfare, so as to cause mixed infections which would tend to confuse the physicians and terrify the public. He would, if possible, select little known diseases with rather long incubation periods, and preferably those which are severe and disabling but not necessarily fatal. It is good military strategy to cripple and incapacitate rather than to kill, since this procedure requires the valuable services of numerous individuals, other than those directly afflicted, and many facilities for the care of the sick.

Among the many biological agents which more or less meet these specifications, and are readily available to an enemy, are the viruses of influenza, poliomyelitis, psittacosis (parrot fever), and encephalitis; the Rickettsia of typhus fever and Q fever; the bacteria of typhoid fever, dysentery, tularemia (rabbit fever), and anthrax; the fungi causing actinomycosis and histoplasmosis; the toxin of botulism; and numerous others. It is extremely unlikely that the enemy possesses any "mystery" germs or maladies with which our scientists are not familiar, but it is likely that he would try to spread certain scourges by unnatural rather than by natural methods. Laboratory accidents have shown that certain viruses and other organisms which are normally spread to man only by insect vectors, such as mosquitoes, fleas, lice, and ticks, can cause disease by inhalation of virulent organisms.

When and if biological warfare is used against us, it seems improbable that it will be employed solely as a separate weapon, but rather that it will come in conjunction with other types of unconventional warfare, such as atomic and chemical attacks. As a matter of fact, the modern atomic bomb is tremendously more devastating to life and property than germ warfare could possibly be, and the so-called nerve gases of chemical warfare are far more lethal. If, however, you add germ warfare to the destruction, disorganization, and panic resulting from these holocausts, you have a fertile field for it, especially during the mass migrations, overcrowding, exposure, breakdown of public utilities, undernutrition, and other hazards of such disasters.

The United States has dealt competently with other calamities, such as earthquakes, floods, hurricanes, explosions, and fires, which have been as dangerous to health as is warfare. With proper organization and intelligent preparation we can deal just as effectively with the emergencies created by atomic, radiological, chemical, and biological warfare. During World War II the British maintained an alert and efficient civil defense organization which reduced casualties from the constant and terrible bombings to a minimum, but the Germans and the Japanese had no such organizations and their bombing casualties were proportionately very much higher.

Protective Measures

Obviously, the first line of defense against biological warfare is the prevention of massive attacks and actions by saboteurs; this is a responsibility of our military and security agencies. If the first fails, the second line of defense is the immediate detection of specific pathogens in the atmosphere following an attack, which is a matter for our public health laboratories. The third essential measure is the prompt recognition and control of all cases of disease by our physicians, sanitary engineers, and public health departments, following the same procedures which are routinely in effect every day in the United States.

These are all measures which would be undertaken by duly constituted authorities for the protection and

(*Concluded on page 66*)

. . . the second line of defense is the immediate detection of specific pathogens in the atmosphere following an attack, which is a matter for our public health laboratories.

Russell C. Aikins from Merck and Company, Inc.

THE INSTITUTE GAZETTE
PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Report of the President

In the Face of a World-Wide Shortage of Scientists and Engineers, M.I.T.'s Responsibilities in Improving Student Life and Educational Environment Are Closely Examined

THE responsibilities of the Institute in the face of a world-wide shortage of technical personnel was the major theme of the President's Report to members of the M.I.T. Corporation at their meeting on October 6. The complete text of the President's Report is worthy of careful study by Technology Alumni. The Review is pleased to present here a condensation of Dr. Killian's report.

"Engineers and scientists continue to be in short supply," said James R. Killian, Jr., '26, President of M.I.T., in the opening sentence of his report, "not only in the United States but throughout most of the world. In the United States the shortage has been aggravated by our defense program but, aside from this emergency demand, the increasing technological complexity of industry and our living environment keeps the demand curve rising."

As against a rising demand for engineers and scientists, President Killian took note of the "unexpected and ill-timed drop in the number of young men entering engineering and certain branches of science" for the past several years. The steadily decreasing enrollment seems to have been partially checked this year, at least at M.I.T. Said Dr. Killian:

What has been our experience at M. I. T.? Our entering class this September numbers 943, an increase of about 200 over last year. I must confess that this is a larger class than we had planned to take, even though applications had greatly increased. We had planned on 800, an increase of about 70 over the previous year. However, the usual number of cancellations did not occur, and we find ourselves with the largest class we have ever admitted at one time. We selected this freshman class out of a total of over 3,000 applicants, and the admissions office staff believes that the average quality of the men admitted is significantly higher than that of the preceding two classes.

If we compare last year's enrollment with the last normal year before World War II, we find that M.I.T.'s total student body had increased from 3,100 to 4,874, or 57 per cent. Over this period the undergraduate enrollment had increased 33 per cent, the graduate enrollment, 139 per cent. Here are the figures:

	Undergraduate	*Graduate*	*Total*
1939-1940	2,379	721	3,100
1951-1952	3,154	1,720	4,874
1952-1953 (estimated)	3,200	1,900	5,100

This comparison points up the significant increase in the number of graduate students. While M.I.T.'s growth in graduate students has been somewhat above the national growth, there has been an increase in graduate study for the country as a whole. This reflects the growing maturity of our schools of science and engineering . . . While the enrollment of the Institute was increasing 57 per cent over the 13-year period, the enrollment in engineering courses increased 43 per cent; in science courses, 113 per cent; in architecture and planning, 90 per cent; and in the field of management, 29 per cent.

Note particularly the shifting pattern of the courses. [*See* "Comparison of Course Enrollment" on opposite page.] Electrical Engineering increased from 434 to 908, over 100 per cent. Mathematics grew from 40 to 147, and Physics from 152 to 514, both over 200 per cent. These spectacular increases reflect national trends in interests and demand, as well as M.I.T.'s developing programs in these fields. They have obviously required severe adjustments in the Institute's staff and teaching facilities. In a few fields our enrollments have not reflected increases in national demand, for example in Biology, Geology, Aeronautical Engineering, and City Planning.

The upward trend in applications for admission facilitates the management of a stabilized enrollment policy. We should seek to re-establish such a policy at the Institute. I think the record is clear that we have accepted our responsibility in meeting the shortages of scientists and engineers. I suggest that in the years ahead we continue to give primary attention to the quality of our enrollment rather than to any increase in numbers. One of the hazards arising out of the current acute demand for scientists and engineers is the temptation to permit educational standards to drop in order to increase enrollments. This is not the way to advance our science and engineering or to serve industry. . . .

In any discussion of the balancing of enrollments with placement demand in science and engineering, I believe it important to point out the probability of periods when placement will be slow. With the memory of June, 1950, still clear, we cannot assure college students in these fields that they will be eagerly sought after in any given year. A sudden demobilization or a severe cutback in the volume of defense production would most certainly result in a period of readjustment when the employment of new graduates would slacken. A recent research personnel study, soon to be published, shows that of all the scientists and engineers engaged in research and development in industry, 50 per cent are now employed on government contracts. This is but one index of the effect of our mobilization economy on the utilization of scientists and engineers.

The evidence seems to be clear, however, that for the long pull the demand for scientists and engineers will be greater than the supply provided by the present and foreseeable level of enrollments and that we should not be governed in our planning by the possibility of temporary short-term fluctuations in demand.

After thus outlining the current needs for trained personnel and the present outlook for enrollment,

President Killian dwelt upon the Institute's expanding educational program:

The Educational Program. The best way to recruit men with creative ability, leadership potential, and public spirit into the scientific and engineering fields is to provide an educational program that will attract such men and permit them to realize their full abilities. This provides the over-all challenge to an institution such as this, which has traditionally been at the forefront in scientific and engineering education. Toward this broad objective, we have kept our sights set on three principal targets in the past several years:

1. The maintenance of the Institute's leadership in professional education in engineering, science, architecture, and management, at both the graduate and the undergraduate level.

2. The enrichment of our program in general education and in those social sciences appropriate to an institute of technology.

3. The achievement of M.I.T.'s goal to become a residential college and the rounding out of our extracurricular activities to make them of maximum educational value to our students.

In consonance with these three aims and in order to provide the means to achieve them, we have kept our sights on still another target – the funding of M.I.T.'s independence and its future, and the provision of new educational and research facilities in order to realize new educational opportunities. In this past year we have moved ahead towards these goals. . . .

At M.I.T., we have always felt the undergraduate school to be the very core of our total program. Within our present phase, we are taking pains to make sure that we are still making creative contributions to the art of undergraduate teaching and that we are providing the best kind of environment and incentive to the teacher who teaches undergraduates with scholarship, professional standards, and inspiring skill. The teacher who can set a young man's mind on fire is an educational institution's most valuable asset. Happily, we have many at M.I.T., and we seek to give them the backing and the opportunity to exert their maximum influence. . . .

As a result of this year's discussion of flexibility versus rigidity, the Faculty has now approved as a first step toward less rigidity a plan whereby alternate groups of subjects will be offered in the first two years. None of the new versions would offer less coverage or difficulty than the courses now offered, but would, on the contrary, provide more depth, scope, and difficulty for those students who are prepared for and desire more advanced work.

. . . By bringing down into the undergraduate school more of the creative research and professional attitude of the graduate school, we have been seeking to do a better job of teaching engineering and science to undergraduates. We have been doing this in part through the use of projects, as, for example, a plant-design problem undertaken by a team of students and requiring the use of judgment in regard to the many different technical and economic aspects of the problem.

. . . Through this project concept of instruction, we have an opportunity to give our undergraduates a real taste of professional practice and to provide them with a more interesting and highly motivated program. Our drive now is to find an undergraduate equivalent for the creative experience of the graduate student – to give the undergraduate an opportunity himself to be creative in terms of his stage of development.

Another important Faculty action during the year was a reinstatement of the requirement for a bachelor's thesis or project. . . .

COMPARISON OF COURSE ENROLLMENT
1939–1940 and 1951–1952

	1939–1940	*1951–1952*	*Percentage change*
Engineering Courses (Total)	2,167	3,094	+43
Aeronautical Engineering	218	246	+13
Building Engineering and Construction	26	94	+262
Chemical Engineering	497	482	—3
Civil Engineering	117	273	+133
Electrical Engineering	434*	908	+109
General Engineering	68	40	—41
Mechanical Engineering	455	526	+16
Metallurgy	124	218	+76
Meteorology	27	115	+326
Mining Engineering	10	—	—
Naval Architecture and Marine Engineering; Naval Construction and Engineering; Marine Transportation	181	171	—6
Sanitary Engineering	10	21	+110
Science Courses (Total)	543	1,159	+113
Biology	75	92	+23
Chemistry	194	258	+33
Food Technology	16	43	+169
General Science	30	20	—33
Geology	36	82	+128
Mathematics	40	147	+268
Physics	152	514	+238
Science Teaching	—	3	—
Architecture and Planning	108	205	+90
Economics and Engineering	—	92	—
Business and Engineering Administration	251	324	+29
Unclassified	31	—	—
Grand Total	3,100	4,874	+57

* Including Electrochemical Engineering

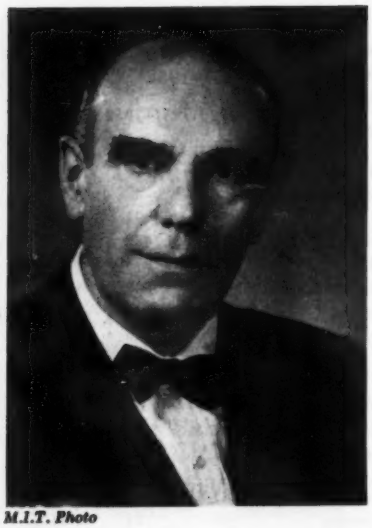
Integrated General Education Program. During the past year, after extended discussion by appropriate committees, the Faculty approved a new four-year integrated program in general education. This core curriculum consists of a two-year introductory course required of all freshmen and sophomores followed by an elective sequence in the junior and senior years in which students will have the opportunity to elect a combination of three subjects in one of eight fields together with a fourth, or distributional, subject in a different field. . . .

The required two-year course is designed to give the student an introductory knowledge of important issues, ideas, periods and events of the past, selected on the basis of their relevance to the world today. It will emphasize the interrelation of the various humanities and social sciences as elements in human experience and introduce the student to the process of critical thought as applied in the humanities and social sciences. Practice in written and oral expression is an integral part of this basic program.

Specialization in the third and fourth years may be in one of the following fields (and in each field there is a choice of subjects): history of ideas; political, social and economic history; literature; music; economics; political science and international relations; labor relations; and psychology. . . .

School of Industrial Management. This fall, the School of Industrial Management, now amply housed in the Sloan

(Continued on page 54)



M.I.T. Photo

Laurens Troost ◀

. . . has become head of the Department of Naval Architecture and Marine Engineering, succeeding Edward L. Cochrane, '20, Dean of the School of Engineering. Professor Troost gained international recognition for his work in naval architecture in the Netherlands, and in 1951 was a visiting professor at the Institute.

Lammot du Pont, '01 ▶

. . . emeritus life member of the M.I.T. Corporation and director of E. I. du Pont de Nemours and Company. In his death, on July 24, the Institute lost an able and active alumnus who had served the Corporation as a life member since 1934.

Du Pont Photo Library

New Head for Course XIII

LAURENS TROOST, whose achievements as a naval architect in the Netherlands have won him international recognition, has been appointed professor and head of the Department of Naval Architecture and Marine Engineering at the Institute this autumn. Professor Troost succeeds Edward L. Cochrane, '20, whose appointment as dean of the School of Engineering at M.I.T. was announced in the May, 1952, issue of The Review.

The Department of Naval Architecture and Marine Engineering, established at M.I.T. in 1893, is the country's oldest course in this field. As head of the department Professor Troost will direct the training of a large group of civilian students, and will also have charge of the graduate course in naval construction for which all naval constructors of the United States Navy come to M.I.T. from the United States Naval Academy.

A native of Rotterdam, where he was born in 1895, Professor Troost was educated at the Delft Institute of Technology, from which he was graduated in 1919 with the degree of naval architect. His early experience was gained as a naval constructor in the Royal Netherlands Navy, in which he was engaged in the design, building, and repair of ships.

In 1929 Professor Troost was asked by the Netherlands Ship Model Basin Foundation to undertake the design, construction and operation of a large modern ship model basin at Wageningen. The basin was opened in 1932 and was operated until September, 1951, under Professor Troost's direction.

In 1946 Professor Troost served on the faculty of the Delft Institute of Technology, and devoted part of his time to reconstruction of the Wageningen model basin, which was seriously damaged during World War II. Also in 1946 he came to the United States at the invitation of the United States Navy to visit a number of laboratories in this country. In 1951 he was invited by M.I.T. to join its staff as a visiting professor of naval architecture. and he lectured at the Institute for the autumn term in that year under a Fulbright award. Later he became a temporary member of the staff of the University of California at Berkeley.

Professor Troost served as a lieutenant and a captain in the Netherlands Artillery Service Reserve from 1916 to 1945, and was a commander in the Netherlands Naval Reserve from 1945 to 1948. In 1937 the Queen of the Netherlands made him an officer of the Order of Oranje-Nassau, and in 1949 he received the gold De Ruyter Medal for outstanding services in the field of shipping and shipbuilding.

He is a member of the Royal Dutch Institute of Engineers and chairman of its section for engineering and naval architecture. In 1947 he founded the Dutch Shipbuilding Research Association and was its first chairman. He is also a long standing member of the Society of Naval Architects and Marine Engineers, the Institute of Naval Architects, the North East Coast Institution of Engineers and Shipbuilders, the Association Technique Maritime et Aeronautique, and Schiffbauteschnische Gesellschaft. Professor Troost has contributed many papers on ship hydromechanics to these societies. He is one of the authors of the handbook *Resistance, Propulsion and Steering of Ships.* In 1933 he organized the first International Conference of Towing Tank Superintendents in The Hague, and out of that conference grew a permanent organization of which the sixth congress was held in Washington, D.C. in 1951.

Lammot du Pont: 1880-1952

LAMMOT DU PONT, '01, emeritus life member of the M.I.T. Corporation and director of E. I. du Pont de Nemours and Company of Wilmington, Del., died on July 24. Mr. du Pont, a term member of the Institute's Corporation from 1928-1933, was elected to life membership in 1934. He became an emeritus life member in August, 1951, at the age of 70.

Born in Wilmington on October 12, 1880, Mr. du Pont received the degree of bachelor of science from M.I.T. in 1901 and then served for one year as a draftsman in Philadelphia. After 1902, however, he devoted

his entire business life to the du Pont de Nemours Company, which, under his presidential direction, developed from a specialized producer of industrial explosives to one of the world's largest and most diversified chemical corporations. He was first employed there in black powder manufacturing operations and in 1914 became director of that department. When the company was reorganized the following year, he was elected a director and member of the Executive Committee; in 1916, a vice-president; in 1926, president; and in 1940, chairman of the Board of Directors. He had also been chairman and vice-chairman of the Executive Committee and a member of the Finance Committee.

Mr. du Pont's other activities included service as: president of the Manufacturing Chemists Association; director of the General Motors Corporation, National Association of Manufacturers, United States Chamber of Commerce, and Wilmington Trust Company.

Mr. du Pont, as a member of the Institute's Corporation, had been active on the Committee on Membership as well as on departmental Visiting Committees in Chemistry, Chemical Engineering, Civil Engineering, Hygiene, Biology, and the Division of Industrial Coöperation.

Professor of Finance

THE appointment of Eli Shapiro as Professor of Finance at the Institute was announced during the latter part of September by E. P. Brooks, '17, Dean of the School of Industrial Management. Dr. Shapiro will be in charge of teaching and research in corporate finance, consumer credit, and the interrelation of business financial policy and the general economy.

Professor Shapiro received the degree of bachelor of arts from Brooklyn College in 1936, and the degrees of master of arts and doctor of philosophy from Columbia University in 1937 and 1945.

From 1936 to 1941 Dr. Shapiro was an instructor in economics at Brooklyn College. During this same period he also served as research associate, Financial Research Program of the National Bureau of Economic Research in 1938-1939; consultant to the Financial Research Program of the National Bureau of Economic Research from 1938-1942; economic analyst in the Division of Monetary Research of the Treasury Department in 1941-1942; and economist for the research division of the Office of Price Administration in 1941-1942.

On active duty with the United States Navy from July, 1942, until February, 1946, Dr. Shapiro received commendations for his work in scheduling tanker requirements for the Pacific Theater, and for statistical studies for the Navy Manpower Survey. He also served with the Reparations Commission of the Office of Strategic Services.

Following his war service, Dr. Shapiro returned to Brooklyn College as assistant professor of economics. In 1947 he was appointed assistant professor of finance at the School of Business of the University of Chicago, where he was named associate professor of finance in 1948 and professor in 1952.

Dr. Shapiro has written extensively for professional periodicals on banking and finance and his books include *Development of Wisconsin Credit Union Movement* and *Money and Banking*, which he wrote with William H. Steiner. He is also an associate author of R. A. Young's *Personal Finance Industry and Its Credit Standards.*

"The Coop" Expands

As effective as any classroom in contributing to the education of Technology students is the Technology Branch of the Harvard Coöperative Society, Inc., affectionately dubbed "The Coop." With a constantly expanding student body to cater to, the Coop found expansion quite as imperative as M.I.T., and has just completed enlargement of its quarters. A vastly enlarged book section was completed in time for the opening of fall classes. High light of the dedication ceremonies on September 9 was the cutting of the traditional ribbon by President Killian, as directors and employees of the Harvard Coöperative Society watch – in anticipation of the annual rush of the Institute's largest class of students.

M.I.T. Photo

D.I.C. Promotions

Two administrative promotions in the Division of Industrial Coöperation at M.I.T. were announced during the summer by Nathaniel McL. Sage, '13, Director of the Division at the Institute. F. Leroy Foster, '25, Assistant to the Director of the Division, has been named associate director, and Paul V. Cusick, assistant fiscal officer of the Division, becomes fiscal officer and assistant director.

Born in Avon, Mass. in 1902, Dr. Foster received from M.I.T. the degrees of bachelor of science in 1925, master of science in 1930, and doctor of science in 1939. Dr. Foster joined the staff of the Institute in 1925 as an assistant in mining engineering and ore dressing in the Department of Mining and Metallurgy. In 1927 he became an instructor in mining, and in 1931, assistant professor – a post which he held until the Department of Mining was discontinued in 1940. From 1934 to 1938 he was in charge of the Institute's Summer Mining Camp in Dover, N.J., and in 1939 he was appointed assistant to the director of the Division of Industrial Coöperation.

During World War II, Dr. Foster served with the War Production Board as a member of the Research Laboratories Industry Advisory Committee. This committee, which supervised the proper handling of priorities for research laboratories, contributed in significant measure to the total war effort. He is a member of the Boston section of the American Institute of Mining and Metallurgical Engineers which he has served in many important posts, including those of secretary, vice-chairman, and chairman. He is also a member of the American Geophysical Union, and from 1947–1950 he served as director of the Cambridge Chamber of Commerce.

Mr. Cusick joined the staff of the D.I.C. in 1944 as chief accountant and has been assistant fiscal officer since 1947. Prior to coming to the Institute he had held posts with the Boston Elevated Railway and with Patterson, Teele and Dennis.

A graduate of the Bentley School of Accounting and Finance in 1939, Mr. Cusick has been a member of the National Association of Cost Accountants, Boston Chapter, since 1942. A member of the Massachusetts Junior Chamber of Commerce since 1945, he was elected its president in 1950. In 1951 he was named a director of the U.S. Junior Chamber of Commerce.

International Communications

Research in the Institute's newly established Center for International Studies received substantial support from The Ford Foundation in two major grants to M.I.T. amounting to $1,000,000. In making the announcement shortly after the opening of the new school year, President Killian said:

> The development of the Center for International Studies, and arrangements with The Ford Foundation for its generous and pioneering support, have been handled for the Institute under the sound and imaginative guidance of Julius A. Stratton, '23, Provost, and of Max F. Millikan, Professor of Economics, who is director of the Center. The creation of the Center marks an increased attention at M.I.T. to the economic and social implications of science and technology.
>
> The program of the Center is interdepartmental in character. It affords opportunities for research to the Departments of Economics and Social Science and of English and History, and touches at many points upon the individual interests of Faculty members in the several Schools of the Institute. Studies undertaken since the beginning of the program have been of basic academic interest and in large part directly related to important problems facing the country.

The funds will enable the Center for International Studies to undertake two important projects. A grant of $875,000 will provide support for a study of international communications over a period of four years. Under this program, the Center will study the nature of information and ideas that reach various kinds of people in foreign countries, the channels by which they are conveyed, and the factors – cultural, psychological, institutional, political, economic – which affect the way people interpret the information and the way they react to it. Since earlier studies have emphasized mass media, such as radio and the press, special attention will be given to other channels.

A second grant of $125,000 for a one-year period will enable the Center to conduct a research program in the closely related field of economic development and political stability, a subject of major interest to the Department of Economics and Social Science. It will include studies of ways in which foreign countries might employ their resources to raise their living standards. Studies of the political, cultural, institutional, and psychological factors that affect economic growth are also contemplated.

Robert K. Lamb: 1905-1952

Robert K. Lamb, lecturer in the Department of English and History at M.I.T., died on August 26. Dr. Lamb was the son of Dr. Robert S. Lamb and the late Sarah Lamb of Washington, D.C., where he was born on May 17, 1905. He was educated in the high schools of Washington and was graduated from Phillips Exeter Academy in 1924, when he entered Harvard University, from which he received the degree of bachelor of arts in 1929, the degree of master of arts in 1933, and his doctorate in philosophy two years later.

He served as secretary to the University for Information at Harvard from 1928 to 1932, when he became a tutor and instructor in economics for four years. He lectured at Harvard in the field of general education again in 1948. He had served as assistant professor and later as associate professor at Williams College for three years beginning in 1936. Dr. Lamb was legislative representative of the United Steel Workers of America from 1943 to 1947. From 1938 to 1940 he was a special investigator for the Senate Committee on Education and Labor. Beginning in 1943 for four years he was staff director of the House Committee on Interstate Migration.

Dr. Lamb joined the Institute staff as a research associate in 1948 and was appointed a lecturer in 1949, while part-time instructor in English.

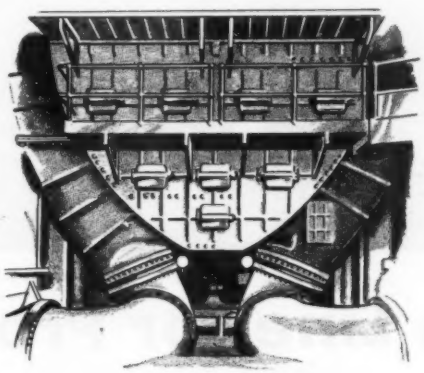
(Continued on page 42)

BUSINESS IN MOTION

To our Colleagues in American Business . . .

Everyone who has to deal with water and steam is concerned with the reduction of corrosion. Power plants, for example, spend large sums annually to treat boiler feed water, and condenser operation is watched carefully. Because of this, the Revere Research Department over a long period of years has studied intensively the causes of corrosion, and how corrosion can be reduced, as it usually can.

Recently the Revere Research Department was asked to investigate the failure of Admiralty metal tubes after some five years of use in a condenser. The user felt such tubes should last longer under average conditions. Samples from failed tubes were sent to the laboratory, and subjected to physical, metallurgical, chemical and microscopic tests. It was found that the outer surfaces were pitted, thinned, grooved and cracked. In some places corrosion had completely destroyed the tube wall. Inside, there was but little pitting of the underlying metal. Thus, it was evident that the destructive process took place on the outside, or steam side of the tube.



The chemical analysis of the outside scale was evidence that the excessive corrosion was due to carbon dioxide and other non-condensable gases carried along with the steam. It is not unusual to have these and other corrodents present in damaging amounts in the air-ejector system, whereas they are not injurious elsewhere.

Photomicrographs were then taken of sections through the cracks. It was found that the cracks originated in corrosion pits on the outside of the tube, and progressed inward. In doing so they broke across the grains of the metal rather than following the grain boundaries. This transgranular pattern showed that the pits created stress-concentration points of weakness. Other characteristics of the microstructure confirmed that failure was due to a combination of corrosion and fatigue. The conclusion was, of course, that not only were there corrodents in the steam, but that in addition the tubes were subject to vibration.

Given these facts, the remedies were not difficult. The copper-base tube alloy that generally possesses the greatest resistance to the non-condensable gases responsible for such corrosion is 5% aluminum bronze. This is somewhat more expensive per pound than Admiralty metal, but in this case when balanced against the expected extension of life, the ultimate cost became favorable. It was also recommended that steps be taken to reduce tube vibration materially by installing a baffle in the steam inlet. Finally, it was pointed out that many operators find it good practice to discharge the after-condenser drain to the sewer, instead of returning it to the system, thus substantially reducing the amount of carbon dioxide, ammonia and other corrodents in the system.

This report provides a typical example of the thoroughness with which the Revere Research Department attacks the problems that are brought to it. If you have questions concerning the selection, fabrication, or service of Revere Metals, get in touch with the nearest Revere Sales Office, through which the experience of our Technical Advisors, and if necessary, of Research, can be made available to you. And do not forget that other suppliers to industries of all kinds also operate laboratories upon whose knowledge you can call. It will pay you to do so.

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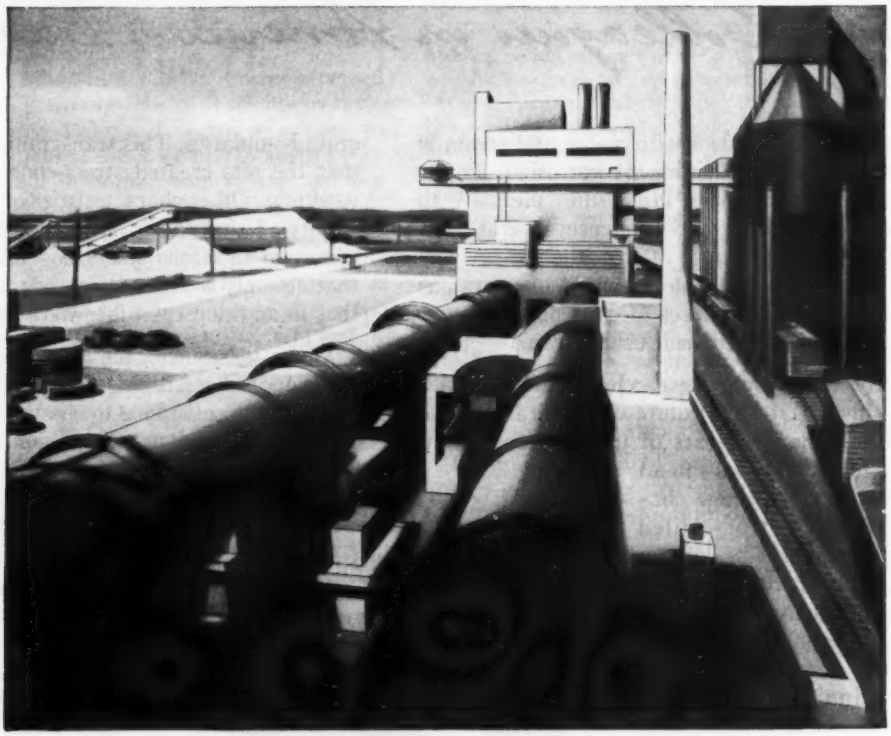

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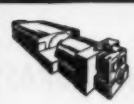

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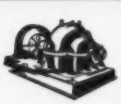

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THE INSTITUTE GAZETTE

(Continued from page 38)

Record Enrollment

WITH an entering class of 945 freshmen, and a total enrollment of 4,979 students in all classes, the Institute's body this year is the largest to enter M.I.T. An innovation this autumn was the required attendance of all freshmen at orientation exercises, beginning on Thursday, September 18, prior to the official registration on Monday, September 22, for upperclassmen and graduate students. Another change, which aims to enable new students to derive maximum benefit from their course of study, is the assignment of Faculty members as advisers to freshmen. Some 45 Faculty members have been designated to serve in this capacity, and each such adviser will be available for consultation by some 20 freshmen. In addition, senior students have also been designated to assume certain responsibilities for welfare of entering students.

The large entering class is a particularly happy omen at the present time when the demand for persons trained in engineering, science, and architecture greatly exceeds the number of graduates.

The Class of 1956 had its first gathering, as a group, on September 18 in Rockwell Cage. At the Freshman Dinner that evening, President Killian welcomed the new class and stated: "Freshmen entering college always have to feel their way through a certain amount of murk and fog, and so will you. The objective is to find your way out as soon as possible, and it is the purpose of this week end to help you." Dr. Killian also spoke of the freedom and responsibilities facing the new students at the Institute in the following words:

In coming to college, particularly to M.I.T., you have assumed responsibilities not only to be your own boss and to take responsibility for your intellectual development but to accept your proper share of the responsibility of governing this student community. . . . Here at M.I.T. we believe in and have student self-government which is genuinely free and independent. . . . You will find this accent on student freedom and responsibility to be one of the hallmarks of M.I.T. . . . The freedom we espouse is not freedom to do as one likes if this injures someone else, or to live an unbridled existence, or to be selfishly thoughtless of one's neighbor. The freedom we espouse does rest upon the principle that a group of students of good will and serious purpose can join together in their own way to adjust their separate interests to a common cause. It rests upon a recognition of the basic democratic principle that each individual can serve his personal and individual needs best by making himself a part of a community that maintains standards and order for the good of all. This kind of student government is not something to which students are subject, but something of which they are a part, not an authority which they petition, but a common responsibility which they share.

Liaison with Industry

WILLIAM R. WEEMS, '35, Industrial Liaison Officer at the Institute, has been appointed director of M.I.T.'s Industrial Liaison Program, according to an announcement by Walter H. Gale, '29, Secretary of the Institute.

In his new post Mr. Weems will be in charge of a program that has pioneered in achieving a close cooperation between industrial and academic research

(Continued on page 44)

Sidney B. Moody

Reminiscent is this photograph of the celebration of the Class of 1902 at its 50th reunion which was held at the Coonamessett Ranch Inn in North Falmouth. The 35 classmates shown in the illustration forgathered there for the week end preceding Alumni Day which was held on Monday, June 9. Seated in the front row, from left to right, are: Frederick H. Hunter, Redfield Proctor, Dr. William J. Mixter, Harold A. Everett, Henry H. Saylor, Claude E. Patch, Stephen A. Gardner, Benjamin E. McKechnie, Burton G. Philbrick, J. Albert Robinson, and Grant S. Taylor. In the back row, standing, from left to right, are: William M. Bassett, Russell B. Lowe, Dana H. Fisher, Dr. Charles G. Mixter, Charles W. Kellogg, William R. Greeley, Edwin E. Nelson, Alfred W. Allyn, James C. Howe, Francis B. Galaher, Lewis E. Moore, Wilbur L. Vatter, Chauncey P. Manning, Royal L. Wales, John R. Marvin, Irving W. Reynolds, Albert A. Haskell, Arthur P. Hall, Frank H. Smith, Kenneth C. Grant, Arthur L. Collier, Farley Gannett, Lester C. Hammond, and Charles F. Gardner.

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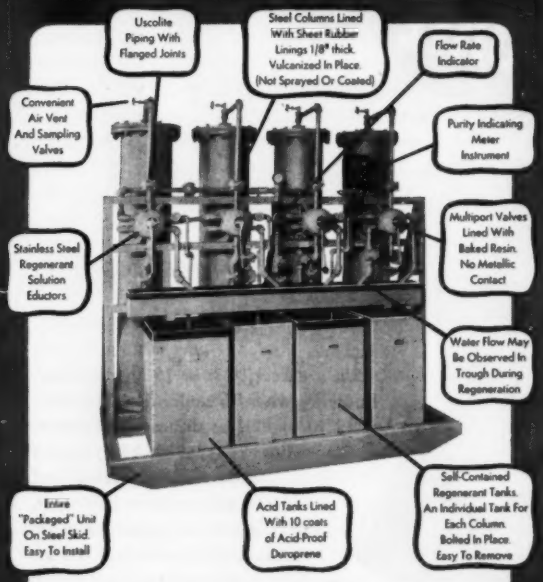
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THE INSTITUTE GAZETTE

(Continued from page 42)

activities. In commenting on the significance of the program to American industry, Professor Gale said:

Our country's dynamic industrial economy is to a great extent a product of technological progress. This progress is fashioned in the commercial developments of our great industrial laboratories and in the creative research of our leading academic institutions.

Realizing that America's industrial leadership must continue to derive vigor from both industrial and academic sources, the Institute initiated in 1947 its Industrial Liaison Program for correlating and strengthening the work of both. This unique program affords industry a direct link with the entire range of researches at the Institute and actively attempts to bridge the gap between M.I.T.'s own creative efforts and industry's commercial development of the results. The program also assures a more realistic orientation and vigorous implementation of the Institute's basic educational efforts.

Since its establishment the program has experienced a sound and steady growth because of its success in contributing to a satisfying course of progress both in industry and at the Institute. With this growth the program has become an increasingly important vehicle of service to industry and to the nation in the fields of science, engineering, and industrial management.

Associated with the Industrial Liaison Program since 1950, Mr. Weems has a rich background of experience in administration, teaching, and research.

The son of missionary parents, he was born in Kaesong, Korea, on August 9, 1911. Sent to the United States for his higher education, he was graduated with honor from the Georgia Institute of Technology in 1933. After a short term as a flying cadet and as a graduate assistant at Georgia, he accepted a scholarship for postgraduate study at M.I.T. where he received the degree of master of science in 1935.

Following his graduate study, he worked as a development engineer on aircraft instruments at the Pioneer Instrument Division of Bendix Corporation. In 1937 he returned to the Georgia Institute of Technology where from 1937 to 1941 he was instructor and later assistant professor of aeronautical engineering.

During World War II he served in the Army Air Forces with the rank of lieutenant colonel. From 1941 to 1943 he was executive officer of the Special

(Continued on page 46)

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Eric Martin Wunsch, II, '44

THE INSTITUTE GAZETTE

(*Continued from page 44*)

Weapons Branch at Wright-Patterson Air Force Base where he was also head of the gyroscope laboratory. In 1943 he was promoted to assistant commandant of the Army Air Forces Engineering School at Wright-Patterson Air Force Base, and until 1945 was in charge of organizing and operating this distinguished professional school which has now become the U.S. Air Force Institute of Technology.

In 1946 he returned to M.I.T. as assistant professor of aeronautical engineering and in 1948 was promoted to associate professor in that Department. Until his appointment as technical industrial liaison officer in 1950, he worked under Professor C. Stark Draper, '26 (Head of the Department of Aeronautical Engineering), in M.I.T.'s Instrumentation Laboratory as an expert on gyroscopes and similar devices.

On Matters Mathematical

MEMBERS of the Visiting Committee on the Department of Mathematics* met on December 3, 1951, with James R. Killian, Jr., '26, President of M.I.T., George R. Harrison, Dean of the School of

(*Continued on page 48*)

*Members of this Committee for 1951-1952 were: Harlow Shapley, chairman, James M. Barker, '07, Charles A. Thomas, '24, Donald C. Spencer, '36, Claude E. Shannon, '40, Saunders MacLane, and James J. Stoker, Jr.

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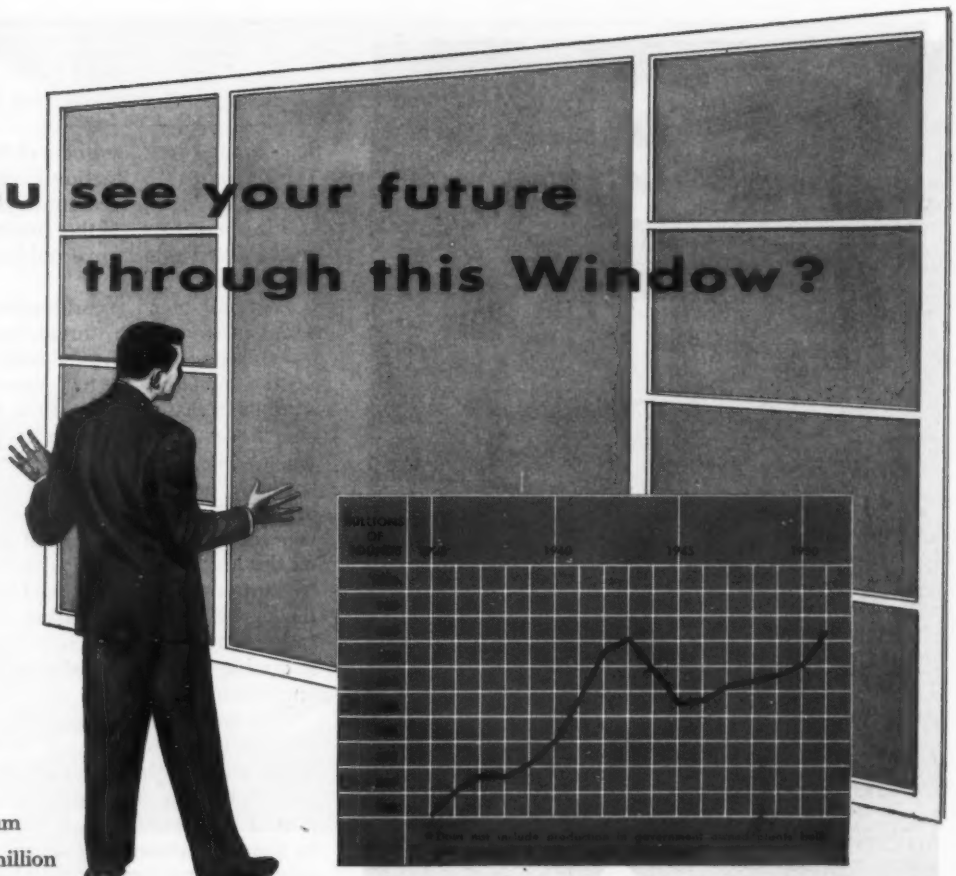

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THE INSTITUTE GAZETTE

(*Continued from page 46*)

Science, and four members of the Department's staff. The report of the Visiting Committee was presented at the June, 1952, meeting of the M.I.T. Corporation and on September 9 the Institute's Executive Committee voted to approve publication of this report in The Review.

The staff of 18 of professorial rank and 35 additional instructors, lecturers, teaching assistants, and research assistants are annually engaged in teaching 2,500 graduate and undergraduate students in 87 sections of mathematics at the Institute. Of this number, 56 sections are made up primarily of first- and second-year students, 14 sections of mixed undergraduate and graduate students, and the remainder of students taking courses in intermediate and advanced subjects. Because of the heavy load placed on the Mathematics Department to teach half of the Institute's student body, the Department is faced with the desirability of increasing the size of its staff. The ratio of students to Faculty members at the Institute is double that which exists at two other well-known engineering schools.

The need exists for one or more appointments to the permanent tenure staff in order properly to cover fields now neglected (such as number theory and probability) or understaffed (such as ordinary and partial differential equations). The need also exists in the Department for an increased budget for the teaching of undergraduate elementary courses in the Summer School.

It was noted with gratification that the caliber of the work of the graduate students in Course XVIII has improved steadily during the past several years, and that the standards which the Department sets for graduate students have risen. During the last few years the number of advanced graduate courses offered by the Department has likewise increased. This growth has been of high value to the Institute's advanced students, and has also resulted in a considerable increase in the number of students who come from other institutions to take courses of study at the Institute.

Research is being conducted in the fields of algebra, analysis, cybernetics, differential equations, elasticity, hydrodynamics, and topology. The research in dif-

(*Continued on page 50*)

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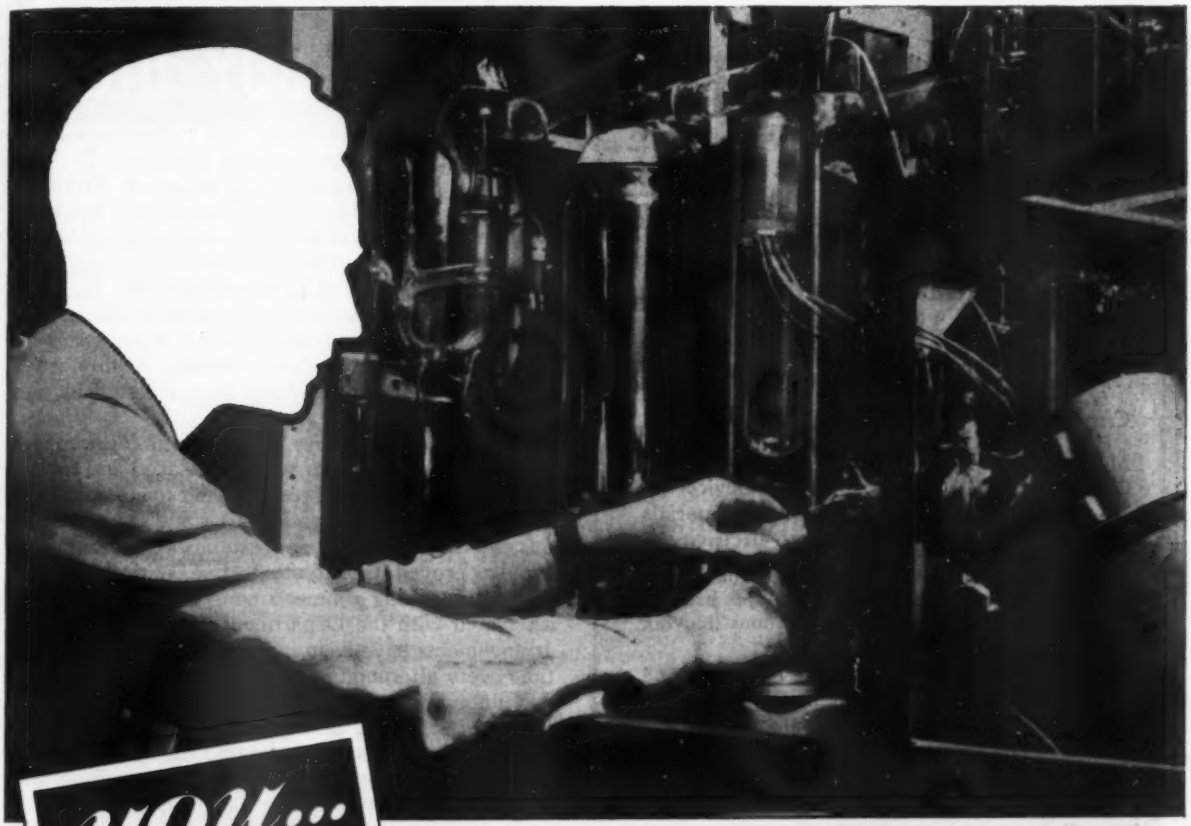

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THE INSTITUTE GAZETTE

(Continued from page 48)

ferential equations, elasticity, and hydrodynamics is sponsored by the Office of Naval Research.

During the year covered by the report, Professor William T. Martin, Head of the Department, has been on leave of absence from M.I.T. for advanced study. Professor Norman Levinson '33, has been acting head of the Department, and George B. Thomas, Jr., Associate Professor of Mathematics, executive officer. The text recently adopted for the first three terms of calculus, written by Professor Thomas, is still not yet in final form, but already has been adopted for use at another engineering school.

The Department tries to foster an atmosphere where staff and students will feel relaxed and free to co-operate in study and research and to communicate with one another their enthusiasms and criticisms. To this end the Common Room, established several years ago, has proved itself most effective. With the idea of further increasing contact among all the individuals associated with the Department as staff or students, arrangements have been made to serve tea at a fixed time every afternoon in a pleasant room.

Maintaining personal contact with mathematicians in other institutions here and abroad is also very important in promoting morale, and the staff has been very active in this respect. Visitors come here and

(Concluded on page 52)

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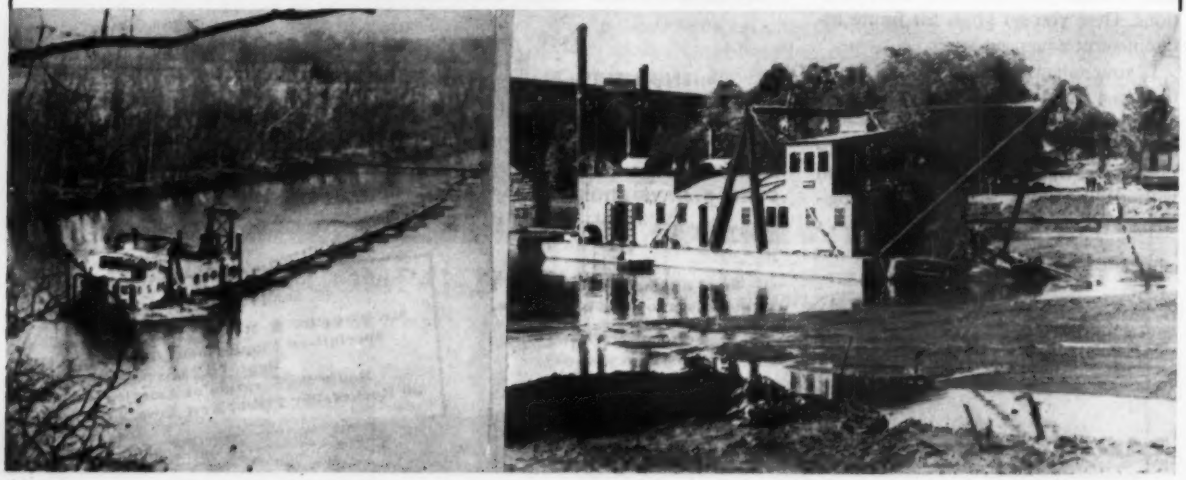

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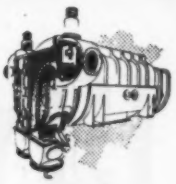

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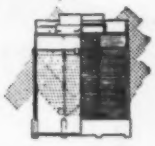

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Elton E. Staples, '26, Vice President

THE INSTITUTE GAZETTE

(Concluded from page 50)

our staff visits elsewhere, sometimes just for a day or two and occasionally for as long as a year. One aspect of this activity – attendance at meetings of professional societies – is at present supported on the rather restricted basis of not more than one meeting during a year for any individual and then only if he is presenting a paper.

Research on City Planning

APPOINTMENT of Louis B. Wetmore, '36, of Providence, R. I., as Visiting Professor of City Planning at the Institute was announced during the summer by Pietro Belluschi, Dean of the School of Architecture and Planning.

Mr. Wetmore, who will be on leave from his post as chief of the Planning Division of the Rhode Island Development Council, will serve in the Institute's Department of City and Regional Planning for the academic year 1952-1953. At M.I.T. he will be principally engaged in directing the establishment of an interdepartmental program of research on metropolitan regions, and he will also teach a course in advanced city and regional planning.

Before World War II, Mr. Wetmore was director of the Tri-Cities Planning Project in Johnson City, Tenn., after having served on the staff of the Division of State Planning in New York and the Planning and Housing Division of Columbia University. After war service as an air intelligence specialist with the U. S. Army Air Force, he became senior planner with the Providence City Planning Commission.

Promotions in Research Administration

ALBERT G. HILL, Professor of Physics and former Director of the Research Laboratory of Electronics at M.I.T., has been appointed director of the Lincoln Laboratory, an electronic research project operated by the Institute for the Department of Defense, Julius A. Stratton, '23, Provost, announced during the summer.

Jerome B. Wiesner, Professor of Electrical Engineering and Associate Director of the Research Laboratory of Electronics, has been appointed as the new director of this laboratory.

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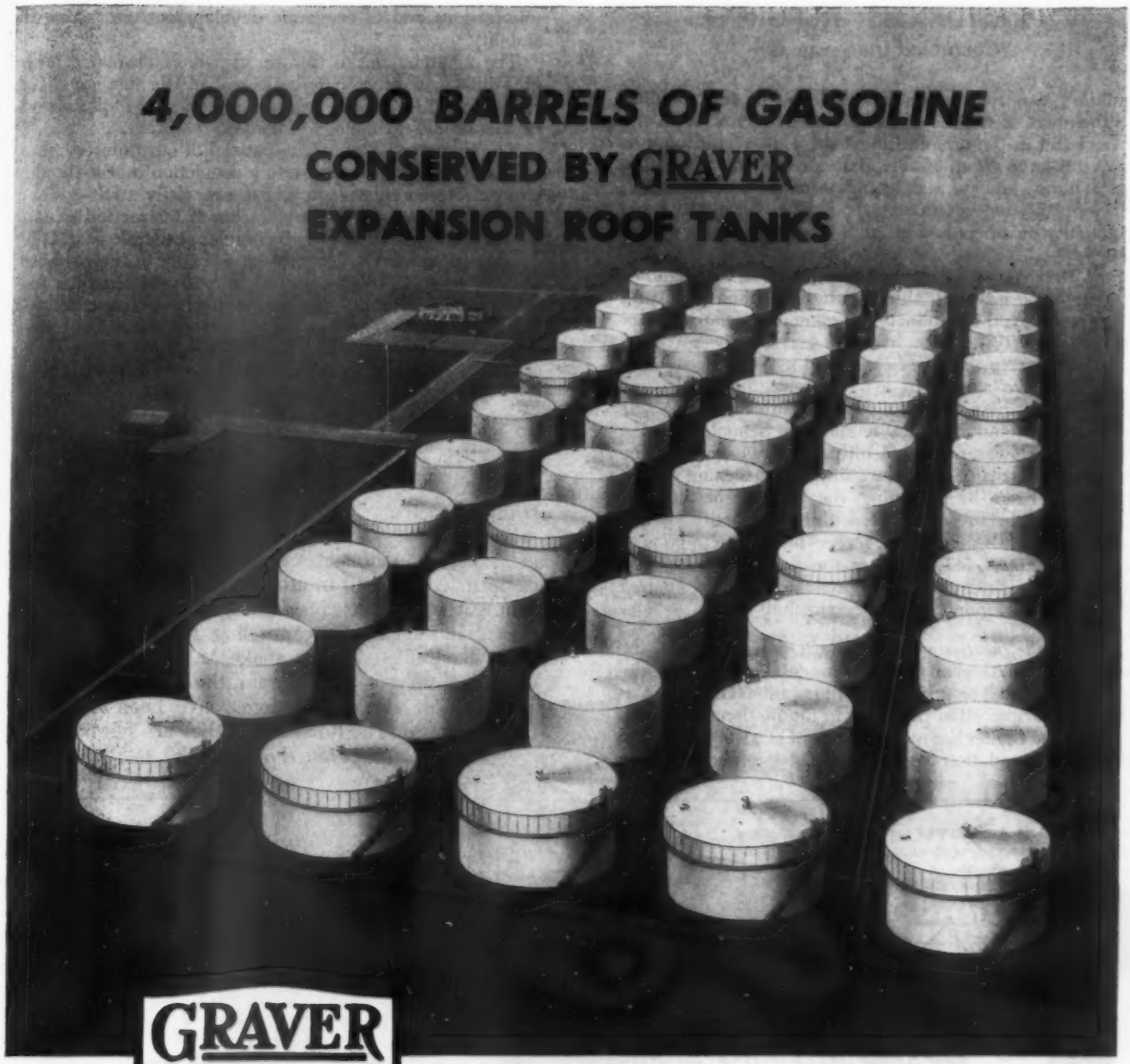

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PRESIDENT'S REPORT

(*Continued from page 35*)

Building, expects a graduate enrollment of 48, including 18 members of the Sloan Fellowship Program. With the School still in the organizational stage, it is gratifying to have this large group of able graduate students. Over 200 sophomores, juniors, and seniors enrolled in Course XV, make up the undergraduate school. The School will have 20 faculty members and an additional staff of 18, a total staff which is larger by over one-third than last year's staff of the Department of Business and Engineering Administration which has been absorbed by the School. In April, Professor Ronald H. Robnett was named associate dean of the School.

In developing the new School and in selecting its Faculty, we have sought to avoid duplication of existing schools of business. Repeating the old patterns would have been the fast and easy way to start the School; we have chosen the slower, more difficult path of re-examining the premises of management education and of seeking a fresh approach. From its beginning, the program of this new School should represent creative thinking about management. Toward this end, "task forces" have been appointed by E. P. Brooks, '17, Dean of the School of Industrial Management, to devise new approaches and new content for important segments of the curriculum. . . .

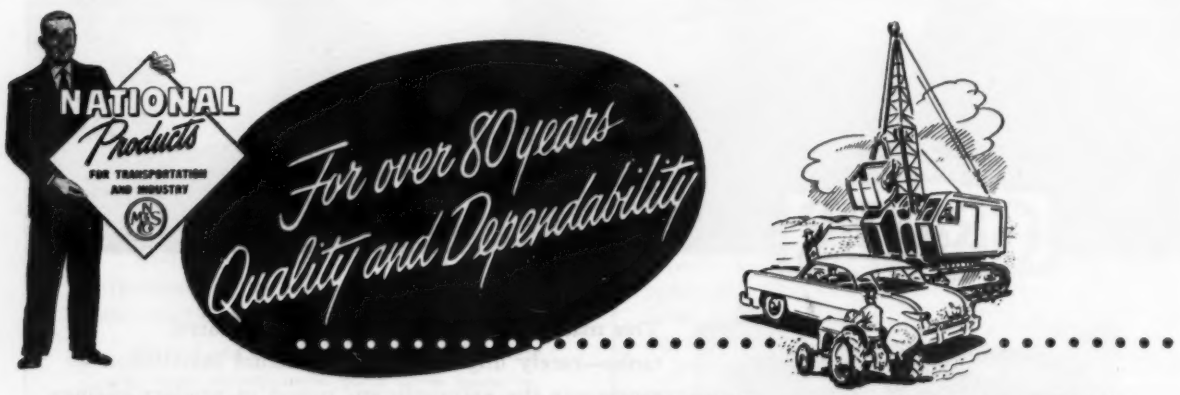
Center for International Studies. During the year, the Institute established an interdepartmental organization devoted to research on problems of international communication and various other problems in international relations. Already the Center has received a grant of $1,000,000 from the Ford Foundation for its studies of international communications and of economic development and political stability.

The creation of the Center, of which Professor Max F. Millikan is director, is indicative of the increased attention at M.I.T. to the economic and social implications of science and technology at home and abroad. . . .

The Summer Session. The pattern of our Summer Session is changing in response to a conviction that it should concentrate on special programs, especially adult education, and minimize routine subjects of instruction which repeat work offered during the regular academic year. It is my hope that we can convert our Summer Session almost entirely to special conferences, courses, and seminars for professional personnel in industry, government, and educational institutions. Such a program would have more appeal for the Faculty and would enable Faculty members, in my judgment, to make a greater contribution to our professional objectives. Additionally, it would reduce their summer load. . . .

For perhaps the last decade and a half, significant changes in student life have taken place at the Institute, but they have been proceeding at an accelerated rate since the end of World War II. The expansion in student housing, in facilities for "on campus living," and in athletic provisions, the establishment of Faculty residents in domiciles for students, and increased counseling for incoming students have all tended to make M.I.T. of the 1950's quite a different place from the Institute of the 1930's. Most of these changes have been recorded in the pages of The Review, but they are summarized

(*Continued on page 56*)



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TEST #2 AT AN ARMED FORCES TEST LAB

Since a terminal has but a few milliohms resistance, this test required a special transformer to match this low impedance to the input of the amplifier, sensitive to levels of 0.2 micro volt. 60 AMP solderless terminals crimped to short lengths of wire in series, a similar number of carefully soldered joints, and a single piece of solid wire of equivalent R, were compared.

No noise difference was detectable between any of the three.

TEST #3 AT A PROMINENT UNIVERSITY LAB

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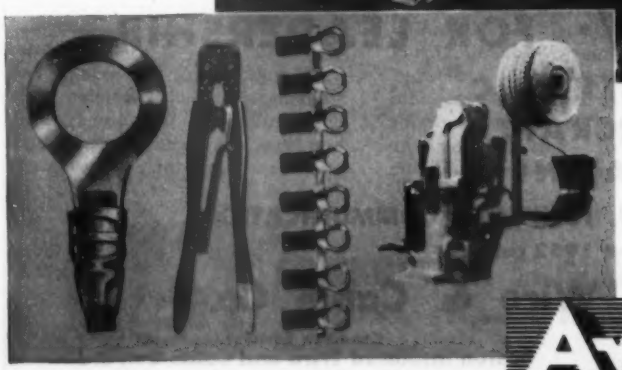

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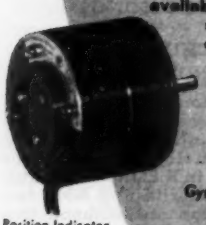

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PRESIDENT'S REPORT

(*Continued from page 54*)

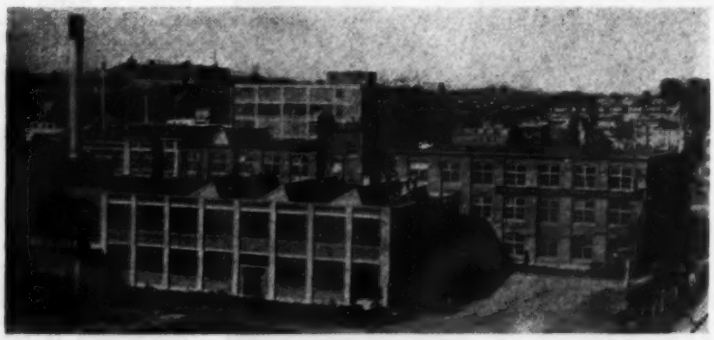
in that portion of the President's Report which deals with Student Life. On this important subject President Killian reports:

The Faculty, the Dean of Students and his associates, and the students themselves have contributed towards our progress this past year in increasing the educational effectiveness of the non-curricular aspects of student life at the Institute. Every effort is being made by the Administration and by the Faculty to create at the Institute an atmosphere in which each member of the student body feels that he as an individual is important and to make sure that each student knows where he can obtain help on educational or personal matters if he feels that he needs it. . . .

Counseling Freshmen. Special attention is being given to helping freshmen as they adjust to life at the Institute. Faculty action has led to the establishment this year of a Freshman Advisory Council, each Faculty member of which will act as adviser, and eventually as registration officer, for approximately 20 freshmen. This group has been authorized to develop a program of guidance on course selection and to facilitate the transition to life at the institute. . . .

This year all freshmen not living at home or in fraternities are required to live on campus. They are divided among all three living units so that they live in association with upperclassmen. This year, too, a subcommittee of student government is inaugurating a new student program, whereby volunteer seniors will serve as counselors to freshmen, each senior counselor being assigned 10 freshmen. . . .

(*Continued on page 58*)



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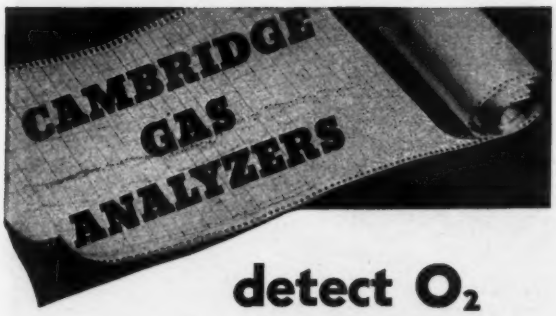

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PRESIDENT'S REPORT

(Continued from page 56)

The inadequacy of undergraduate scholarships reflects a national inadequacy in the scholarship funds of schools of engineering and institutes of technology. These institutions are strikingly poorer in scholarship funds than the top liberal-arts universities. In my judgment this discrepancy works to the disadvantage of the engineering profession and it has played a part in the declining enrollments in engineering. We wish to be sure that exceptional young people interested in these fields are not denied a superior education for financial reasons.

In the judgment of the Institute's Administration, our undergraduate scholarship awards should be increased by at least $200,000 per year within the next five years. . . .

E. Francis Bowditch, Dean of Students, and Thomas P. Pitré, Dean of Freshmen, have proposed the establishment of 25 national scholarships of substantial stipend and have presented convincing arguments that such an addition to our undergraduate scholarship program would help significantly in our admissions program. . . .

During the past year we undertook for the first time to co-ordinate the three forms of student aid (scholarships, loans, and work opportunities), Dean Pitré having assumed administrative cognizance over all three.

Turning to other important Institute activities, President Killian devoted sections of his report to the Faculty Club, International Perspective, New Educational Facilities, Research for the Government, and a discussion of regular financial and administrative matters. Said Dr. Killian:

The Faculty Club. Occupying the top floor and penthouse of the Alfred P. Sloan Building, the Faculty Club opened its doors in May, ushering in a welcome new era in the community life of the Institute and splendidly fulfilling one of the desiderata long urged by the Faculty. . . .

The facilities include a main dining room with accommodations for 200, four private dining rooms, several rooms for overnight guests, a lounge, game room, and other pleasant appurtenances appropriate to a social club. . . .

International Perspective. Earlier in this report I spoke of the shortage of well-educated scientists and engineers as being world-wide. If the high technology of our national economy poses one kind of demand, the need for men in these fields in the undeveloped regions or less highly industrialized nations is in some respects even more urgent. M.I.T., as one of the world's great centers of scientific and

(Continued on page 60)

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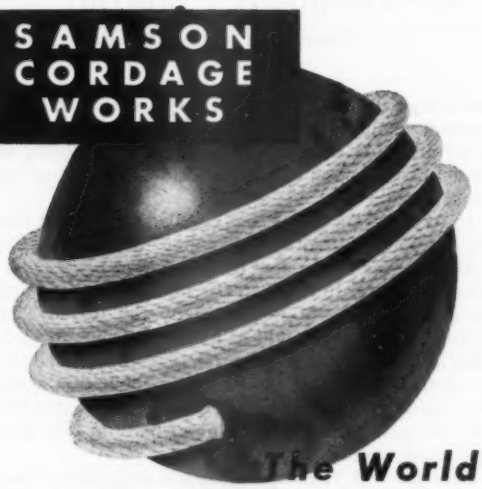

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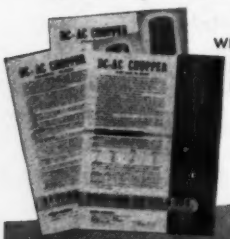

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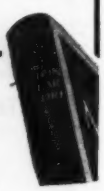

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PRESIDENT'S REPORT

(*Continued from page 58*)

technological education, has a responsibility to the international community to furnish educational opportunity to men from other countries to the limit of its ability and to respond to requests for advice and assistance on educational matters.

In recent years, M.I.T. has enrolled the highest percentage of foreign students of any college in the United States. Last year over 10 per cent of our student body came from other countries. In addition the Foreign Student Summer Project, now largely supported by the Alfred P. Sloan Foundation, Inc., brought 81 men and women from 35 nations to the Institute for research and study in the summer months. This student-run project, which was started in the summer of 1948, has proved eminently successful. The F.S.S.P. now has an active alumni body of 369 members in 40 countries. . . .

Last fall M.I.T. co-operation was enlisted by the State Department in a program of technical assistance to the College of Engineering of the University of Rangoon in Burma. As a preliminary step in working out a program of co-operation between the two schools, Rogers B. Finch, '41, Assistant Professor of Textile Technology, who has been named supervisor of this program, visited the University of Rangoon in March. Following his report, an agreement was entered into whereby the Institute will undertake to recruit up to six staff members for the University. This staff will not only teach, but will also aid in the reorganization of the engineering program. The project is being financed by a grant from the U. S. Technical Cooperation Administration. Professor Murray P. Horwood, '16, of the Department of Civil and Sanitary Engineering, has been granted a leave of absence to head the project staff at Rangoon this year. . . .

New Educational Facilities. Since my last report, two new buildings have been occupied, and another is in the process of being occupied as the school year opens. This has made possible a thoroughgoing reallocation of space throughout the Institute, and there is no Department which has not gained, to some extent at least, by these space changes. For instance, as the Biology Department moves into the John Thompson Dorrance Laboratory, space has been released in Building 10 which makes it possible to consolidate the facilities of the Electrical Engineering Department and to effect a reorganization of laboratories as well as offices which is designed to strengthen the educational program in this field. Similarly, when the Machine Tool Laboratory moved into the new Metals Processing Laboratory, the Department of Graphics moved into the space thus vacated, which in turn made it possible to bring the Business Administration offices together in Building 24. Some idea of the scope of these changes

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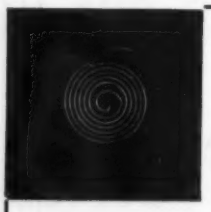

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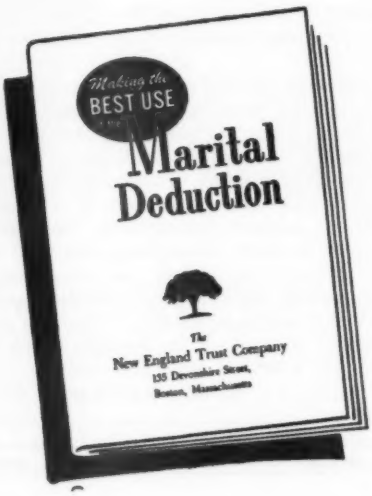

If you are married, the valuation of your estate can be cut in half for Federal tax purposes. But this is possible only if the terms of your will and your other property arrangements meet certain conditions set forth in the 1948 tax law.

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PRESIDENT'S REPORT

(*Continued from page 60*)

may be gained from the fact that for last year and this, the Institute has budgeted $1,250,000 for reconditioning, modernization, and moving costs.

A complete reassessment and reorganization of our library system has accompanied the rearrangement of the academic departments. With the spreading out of the college over a larger area, and immediate problems before us of whether to include new branch libraries in the Dorrance and Sloan buildings, a careful reassessment of our whole library system seemed advisable. In order that we might benefit from the perspective of a person outside the Institute community, The Faculty Committee on the Library enlisted the help of Keyes D. Metcalf, Librarian of Harvard University. Dr. Metcalf made a thorough survey of our situation during the late summer and fall of 1951, and his thoughtful, informed appraisal of our library system provided a sound basis for action.

The reconstituted library organization which is now being put into effect reverses the trend towards too great a proliferation of branch libraries by providing for a limited number of large, well-staffed divisional libraries to replace the existing small and inadequate branches. A General Library will replace the former Central Library, and five large Divisional Libraries will correspond to the five Schools of instruction. . . .

Final working drawings for the auditorium are now being completed, and construction is expected to start this winter. The auditorium will seat 1,200 and has a stage which will accommodate the largest Institute choral groups, as well as the symphony orchestra. The basement is so planned that it can be developed as a small theater and auditorium, to meet the special requirements of our drama groups. The main auditorium will be supplemented by a small devotional chapel which will be available to all religious groups at Technology. . . .

Since before World War II, the Institute has been called upon to engage in an active program of research for national defense. In spite of a drop in these activities shortly after the end of World War II, research at M.I.T. continues at a high level. Of course, the conduct of a substantial amount of research at an educational institution has certain inherent advantages if the two programs are properly interrelated. And although research for national defense fulfills a lofty objective, it also creates many difficult problems. These are discussed by President Killian in his report to the Corporation, from which the following comments are extracted:

Research for the Government. At the end of World War II, the Institute was carrying on defense research involving a rate of expenditure of $50,000,000 a year. By 1945-1946 this government-financed research was reduced to $8,000,000 a year in accord with the Institute's desire to cut back military research to a minimum consistent with our national responsibility. This reduced volume increased slowly in succeeding years until the Korean conflict produced an abrupt and compelling demand upon the Institute and its staff to make their special competence further available to aid the rearmament program. Various research programs at the Institute which were being pursued on a modest scale and with peacetime objectives

(*Concluded on page 64*)

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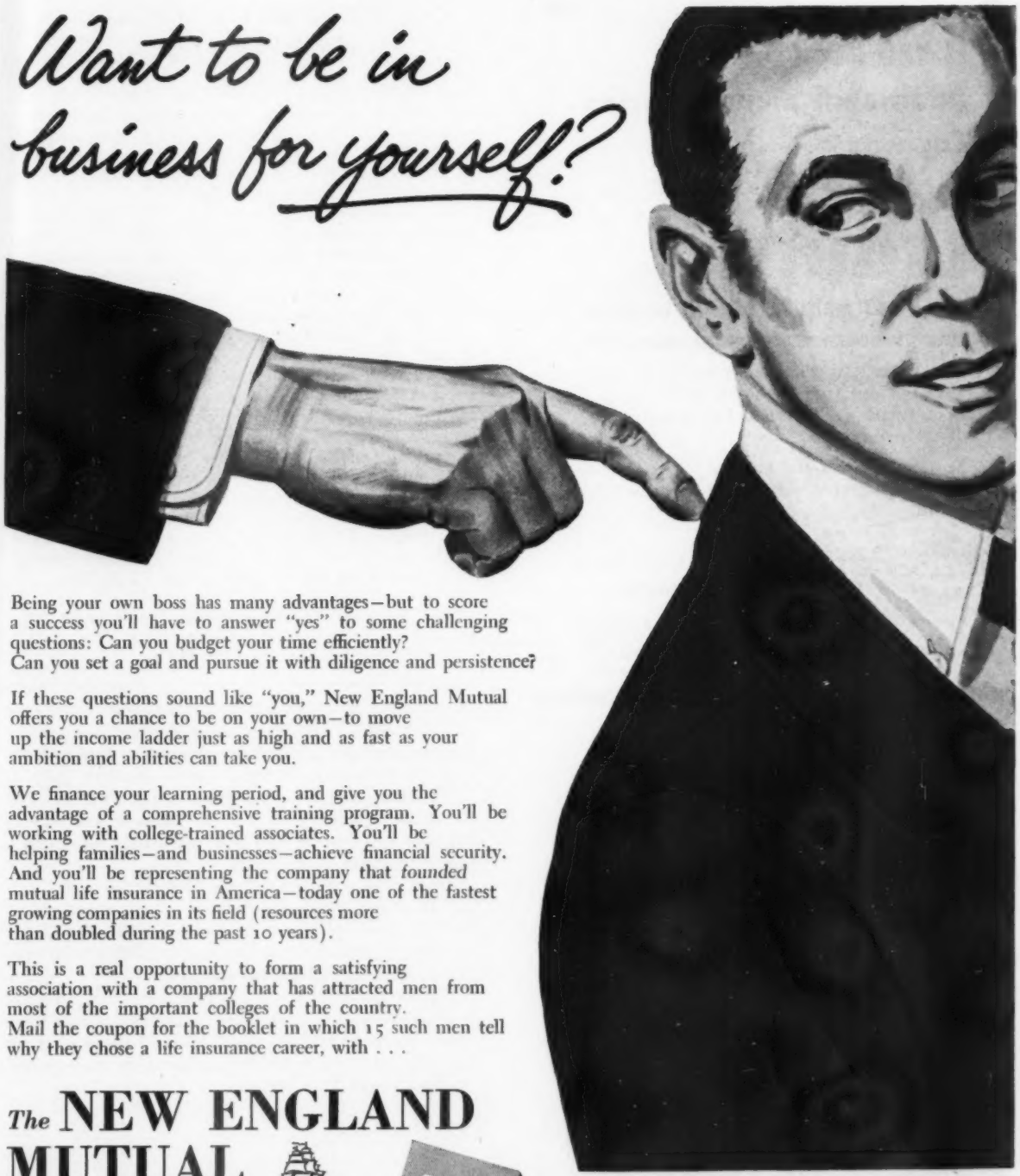

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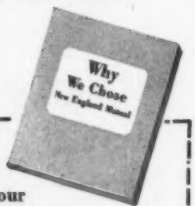

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PRESIDENT'S REPORT

(Concluded from page 62)

were demonstrably of immediate importance to the military services, and we were asked to enlarge them. Certain projects with military objectives which had continued after World War II became quickly of more urgent importance, some even to the fighting in Korea, and obviously we were under obligation to accelerate them.

As a result of these factors and of the Institute's key position as a national center of research, the volume of our research conducted under contract with the government has rapidly risen, not to a total comparable to World War II, but to a total larger than we would wish if we were free of emergency demands. . . .

These are difficult policies to administer. The conduct of large, classified military research projects imposes vexing and heavy burdens on any educational institution. We are acutely aware of the hazards inherent in our government research. We have accepted the large classified projects reluctantly, and we look forward eagerly to the time when they will be no longer necessary. We propose to withdraw from the projects when we have met our commitments or when our participation becomes less than compelling, but we should see our responsibilities through. An institute of technology has special resources which impose on it a responsibility in defense research different from many other kinds of educational institutions. . . .

The Institute's finances reflect the general inflationary trend which marks the entire American economy. Since 1939-1940, the Institute's academic operating expenses per student have risen more than 80 per cent, and they are still increasing as the cost of living rises. This steady upward trend in expenses has required the Institute to increase its tuition from $800 to $900 per academic year, effective July 1, 1953, as reported in the July, 1952, issue of The Review. Additional items of interest on M.I.T. finances will appear in The Review next month as a report from the Treasurer.

Dr. Killian reported that the Committee on Financing Development had validated a long-range objective for new capital resources of some $20,000,000 for additional permanent funds, and $12,000,000 for special facilities over the next few years.

President Killian's report concludes with a recital of Faculty and administrative changes which have taken place during the year. Most of these changes have already been noted in past issues, or are reported in this issue of The Review.

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WHILE we are, of course, constantly looking for new business, it is never our intention to disturb satisfactory relations elsewhere. If, however, any change or increase in banking connections is contemplated, we would like very much to be kept in mind. We welcome opportunities to discuss banking or trust matters at any time.

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BIOLOGICAL WARFARE — MENACE OR MYTH

(*Concluded from page 33*)

relief of the general population, but the people themselves have certain duties and responsibilities. Aside from learning the rudiments of personal and public health concerning germ warfare, individuals would be wise to have themselves immunized against those diseases for which safe and effective methods of vaccination are available. In the United States Army, for example, every soldier is routinely immunized against smallpox, typhoid and paratyphoid fevers, and tetanus, and may be immunized against typhus fever, yellow fever, plague, cholera, and diphtheria when serving or traveling in areas where these maladies are prevalent. As a result of this program, these diseases are virtually absent in our military forces, even if widespread all about them as they are, for example, in Korea.

Biological warfare is, then, definitely not a myth. It is a distinct possibility in the hands of a resourceful and malefic enemy who consistently disregards all the rules of civilized warfare, if any warfare can be called that. Lacking any previous experience with it, the seriousness of the germ warfare menace cannot be stated with any degree of certainty, but it probably is not as threatening as sometimes has been alleged. It is another of those difficult problems which we can overcome if we have to, and there is no reason why we should be needlessly anxious and apprehensive about it. On the other hand, it would be foolish to be apathetic or complacent about it.

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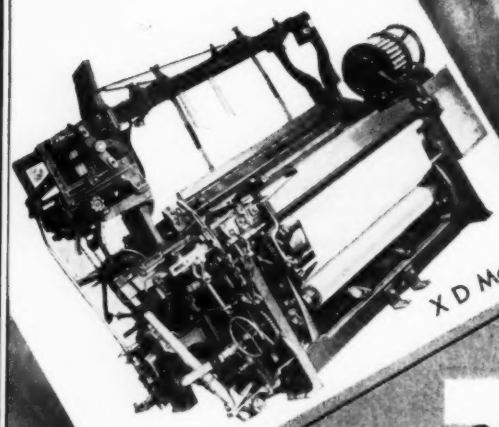

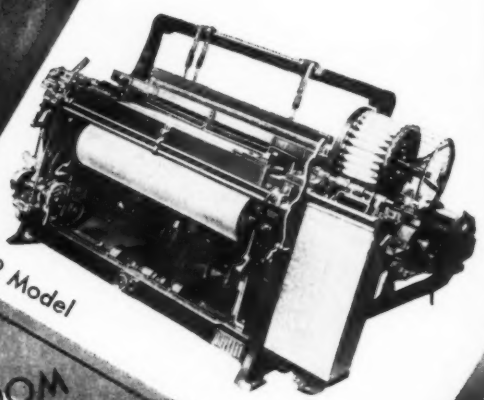

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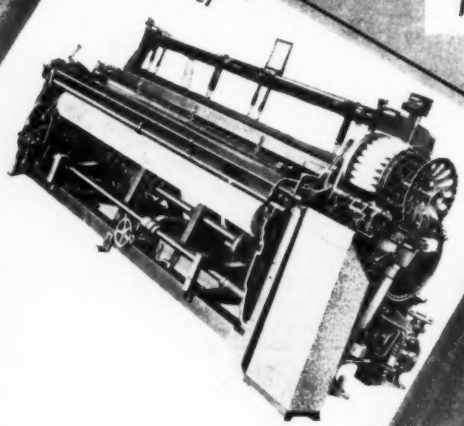

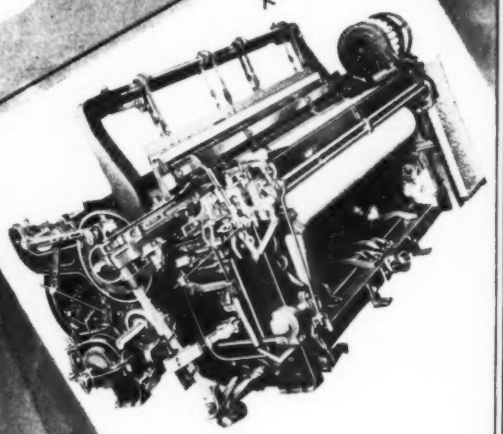

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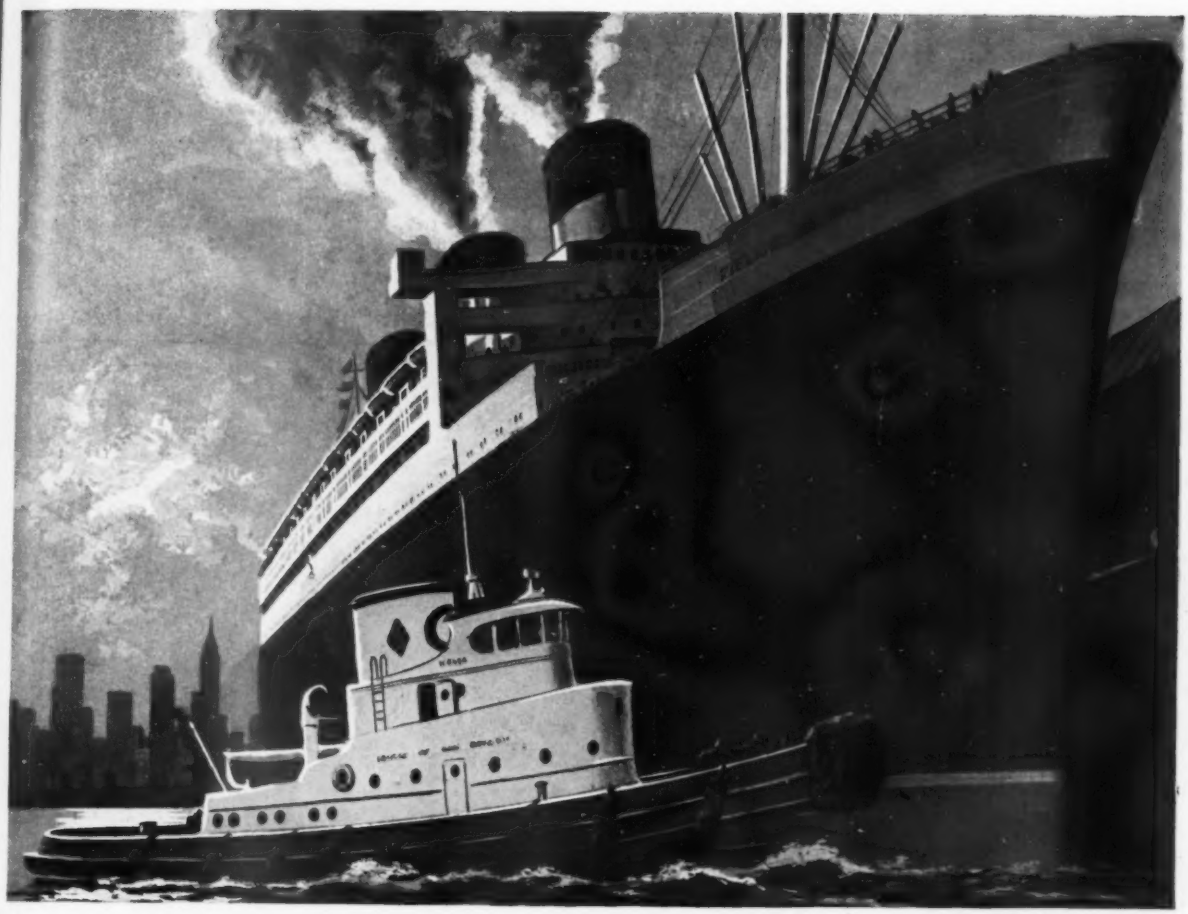

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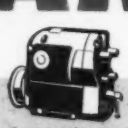

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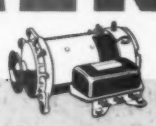

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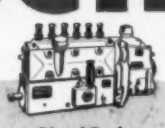

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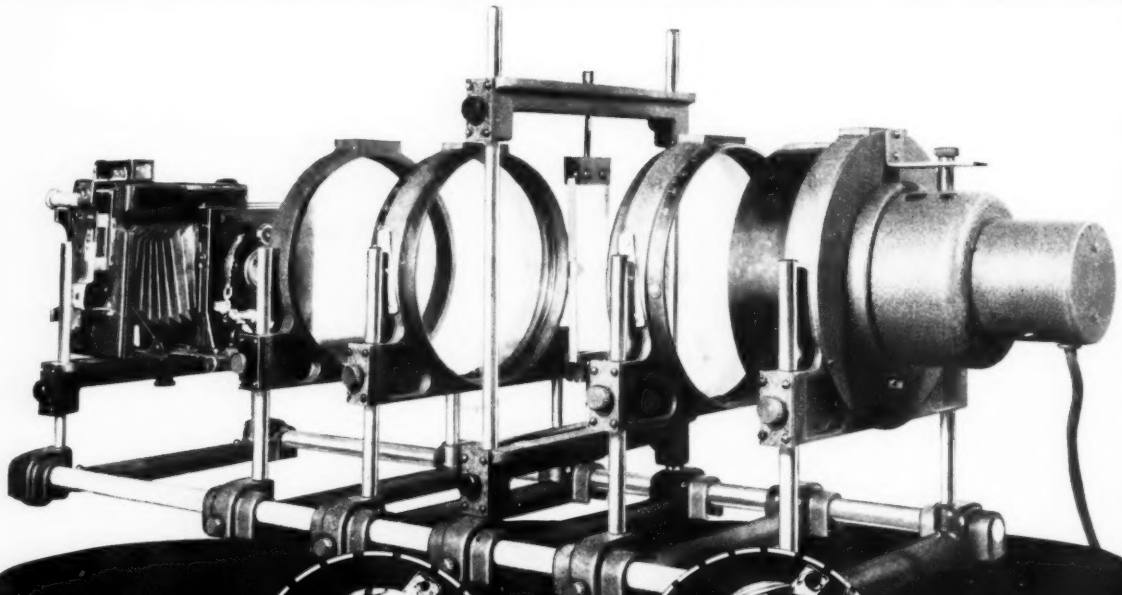

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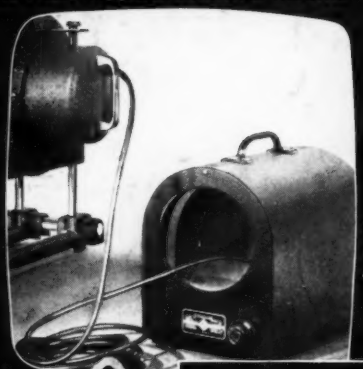

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